OPERATION MANUAL

FM/AM-1000S
FM/AM-1000A

COMMUNICATIONS SERVICE MONITORS

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FM/AM-1000A

COMMUNICATIONS SERVICE MONITORS

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WARNING:

HIGH VOLTAGE EQUIPMENT

THIS EQUIPMENT CONTAINS CERTAIN CIRCUITS AND/OR COMPONENTS OF EXTREMELY HIGH VOLTAGE POTENTIALS, CAPABLE OF CAUSING SERIOUS BODILY INJURY OR DEATH. WHEN PERFORMING ANY OF THE PROCEDURES CONTAINED IN THIS MANUAL, HEED ALL APPLICABLE SAFETY PRECAUTIONS.

RESCUE OF SHOCK VICTIMS

1. DO NOT ATTEMPT TO PULL OR GRAB THE VICTIM
2. IF POSSIBLE, TURN OFF THE ELECTRICAL POWER.
3. IF YOU CANNOT TURN OFF ELECTRICAL POWER, PUSH, PULL OR LIFT THE VICTIM TO SAFETY USING A WOODEN POLE, A ROPE OR SOME OTHER DRY INSULATING MATERIAL.

FIRST AID

1. AS SOON AS VICTIM IS FREE OF CONTACT WITH SOURCE OF ELECTRICAL SHOCK, MOVE VICTIM A SHORT DISTANCE AWAY FROM SHOCK HAZARD.
2. SEND FOR DOCTOR AND/OR AMBULANCE.
3. KEEP VICTIM WARM, QUIET AND FLAT ON HIS/HER BACK.
4. IF BREATHING HAS STOPPED, ADMINISTER ARTIFICAL RESUSCITATION. STOP ALL SERIOUS BLEEDING.

CAUTION

THE USE OF SIGNAL GENERATORS FOR MAINTENANCE AND OTHER ACTIVITIES CAN BE A SOURCE OF ELECTROMAGNETIC INTERFERENCE TO COMMUNICATION RECEIVERS, WHICH CAN CAUSE DISRUPTION AND INTERFERENCE TO COMMUNICATION SERVICE OUT TO A DISTANCE OF SEVERAL MILES.

USERS OF THIS EQUIPMENT SHOULD SCRUTINIZE ANY OPERATION WHICH RESULTS IN RADIATION OF A SIGNAL (DIRECTLY OR INDIRECTLY) AND SHOULD TAKE NECESSARY PRECAUTIONS TO AVOID POTENTIAL COMMUNICATION INTERFERENCE PROBLEMS.

LIST OF EFFECTIVE PAGES

The portion of text affected by the changes is indicated by a vertical line in the outer margin of the page. Changes to illustrations are indicated by revision number. Changes to wiring diagrams are indicated by shaded areas.

Date of issue for original and changed pages are:

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PREFACE

HOW TO USE THIS MANUAL:

SCOPE:

This manual contains instructions for operating the FM/AM-1000S and FM/AM-1000A Communications Service Monitors. The instruction level of this manual is relatively basic and presupposes no previous experience on the part of the operator with a communication serivce monitor of this type. A basic understanding, however, of communication electronics and practical troubleshooting methods will be helpful. It is strongly recommended that operator be thoroughly familiar with Sections 1 through 3 of this manual before attempting to perform any operating procedures contained in Section 4.

APPLICABILITY:

All information contained in this manual applies to both the FM/AM-1000S and FM/AM-1000A models, except where noted otherwise. For reasons of brevity, whenever text information is applicable to both models, the units are referenced as "FM/AM-1000S/A" (instead of FM/AM-1000S and FM/AM-1000A separately).

ORGANIZATION:

The operation manual is divided into the following major sections:

SECTION 1 - INTRODUCTION
Provides a brief introduction to the FM/AM-1000S/A including purpose, functional capabilities and uses.

SECTION 2 - INSTALLATION
Provides a step by step procedure for setting up the FM/AM-1000S/A for operation in either a mobile or test bench environment.

SECTION 3 - DESCRIPTION OF CONTROLS, CONNECTORS & INDICATORS
Identifies and functionally describes all FM/AM-1000S/A controls, connectors and indicators.

NOTE

- As an operating aid, Figure 3-1 (which locates and identifies all FM/AM-1000S/A front panel controls) has been incorporated into a fold-out page. By extending the fold-out page, the operator can easily reference any front panel control while simultaneously performing any operating procedure contained elsewhere in this manual.

SECTION 4 - OPERATION
Contains a selection of basic operating procedures pertaining to all major functions of the FM/AM-1000S/A, in addition to an assortment of common receiver and transmitter tests which can be performed using the FM/AM-1000S/A.

SECTION 5 - UUT RECEIVER TESTING

Contains logical flowcharts which provide operator with a systematic method of:

a. Aligning typical AM/FM receivers.

b. Locating and diagnosing most common malfunctions or breakdowns in typical AM/FM receivers.

Useful supplementary information relating to the operation of the FM/AM-1000S/A is contained in appendices at rear of manual. (See Table of Contents for detailed list of manual contents.)

SUPPLEMENTARY MANUALS:

Refer to separate FM/AM-1000S/A Maintenance Manual for information on following topics:

FM/AM-1000S/A Theory of Operation
FM/AM-1000S/A Maintenance and Troubleshooting Procedures
FM/AM-1000S/A Illustrated Parts Catalog
FM/AM-1000S/A Assembly Drawings, PC Board Layouts and Schematics.

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SECTION 1 - INTRODUCTION

1-1 GENERAL

The FM/AM-1000S/A is a portable communications service monitor capable of performing a variety of transmission test functions normally associated with most types of transceiving equipment (e.g., citizen's band radios, FM two-way radios, single sideband equipment, repeaters and AM/FM/SSB transceivers).

As a portable unit containing an internal rechargeable battery pack, operation of FM/AM-1000S/A is possible almost anywhere without concern for immediate power. Mobile, aircraft or marine operation is possible directly from 11 to 28 volt DC power systems, using a furnished cigar lighter adaptor plug. AC power operation is possible from 115/230 VAC, 47 to 420 Hz power services.

1-2 FUNCTIONAL CAPABILITIES

The FM/AM-1000S/A incorporates the functions of the following test instruments:

FM/AM Receiver
FM/AM Signal Generator
RF Spectrum Analyzer (FM/AM-1000S models only)
RF Frequency Meter
RF Wattmeter
Dual Tone Generator
RF Demodulator
Frequency Standard
Sweep Generator/Tracking Oscilloscope
DC to 1 MHz Oscilloscope
MM-100 Multimeter (Optional; see separate MM-100 Operation Manual for operating instructions.)

These capabilities permit the test set to perform numerous general purpose diagnostic functions, as well as most common transmitter/receiver performance tests, including:

TRANSMITTER	RECEIVER
Frequency Error	SINAD Sensitivity *
FM Deviation	Quieting Sensitivity
% AM Modulation	Receiver Distortion (At maximum deviation)
Power Output	Frequency Stability
Harmonic Content †	Frequency Response
Distortion *	Distortion *
Frequency Stability	Audio Power Output *
Spurious Outputs †	

* Requires MM-100 Multimeter option; functions of multimeter include AC/DC voltmeter, ohmmeter, % AM modulation meter, distortion meter, SINAD meter, selectable audio loads and audio monitor.

† Applicable to FM/AM-1000S models only.

SECTION 2-INSTALLATION

2-1 GENERAL

Installation of the FM/AM-1000S/A is a simple procedure which consists primarily of:

1. Setting instrument into an operating position.
2. Connecting external antenna to test set for "off-the-air" testing.
3. Furnishing electrical power to test set by connecting AC or DC power cable to available power source (unless battery operation is desired).

WARNING

- FOR AC POWER OPERATION, THE 115/230 VAC POWER SELECT SWITCH LOCATED ON REAR PANEL OF FM/AM-1000S MUST BE SET TO THE APPROPRIATE POSITION TO ACCOMMODATE AVAILABLE POWER SOURCE.

This section provides instructions for completing the above procedures with recommendations regarding installation/operation safety, equipment inspection, power requirements and required installation tools.

2-1-1 SAFETY PRECAUTIONS

Listed below are several important safety precautions which must be observed during all phases of installation and operation. IFR Inc. assumes no liability for customers's failure to comply with any of the safety precautions outlined in this manual.

- COMPLYING WITH INSTRUCTIONS
  Installation/operating personnel should not attempt to install or operate test set without reading and complying with all instructions contained in this manual. All procedures contained in this manual must be performed in exact sequence and manner described.

- GROUNDING REQUIREMENTS
  To minimize shock hazard, chassis and case of test set must be connected to an electrical ground. The FM/AM-1000S/A is furnished with an AC and DC power cable, each of which incorporates a ground pin for this purpose. The AC power cable is equipped with a standard 3-pin grounded plug on one end which must be connected only to a properly grounded 3-pin wall receptacle.

WARNING

- DUE TO POTENTIAL SAFETY HAZARDS, USE OF THREE-PRONG TO TWO-PRONG ADAPTOR PLUG IS NOT RECOMMENDED.

The DC power cable features a cigar lighter adaptor on one end.

OPERATING SAFETY

Due to presence of potentially lethal voltages within test set, operating personnel must not remove test equipment covers at any time. Component replacement and internal adjustments must be made by qualified maintenance personnel only.

OBSERVING "CAUTION" & "WARNING" LABELS

Extreme care should be exercised when performing any operations preceded by a "CAUTION" or "WARNING" label. "CAUTION" labels appear where possibility of damage to equipment exists, while "WARNING" notes are used to denote a condition where a shock hazard exists, exposing personnel to possible bodily injury.

2-1-2 EQUIPMENT INSPECTION

All IFR test sets are carefully inspected for material defects and are subjected to a thorough performance check prior to leaving factory. All sets are shipped to customer in excellent mechanical/electrical condition. Upon receipt of shipment, receiving personnel should:

1. Account for presence of all equipment and accessories as listed on packing slip.

2. Inspect all equipment for visible or concealed damage which may have occured in transit. (If damage is apparent, see "RECEIVING INSPECTION/UNPACKING" sticker affixed to shipping container for "Damage Claim" procedure.)

2-1-3 POWER REQUIREMENTS

The FM/AM-1000S/A can be powered from its internal battery pack or from AC or DC power sources. For AC operation, all test sets are equipped with a 115/230 VAC Power Select Switch, which must be set to accommodate the power source available at the operating site. Prior to making any AC power connections, installation personnel must check 115/230 VAC Power Select Switch Setting against the available power source rating, to make sure both are same. DC operation using furnished DC power cable is possible from any 12 V or 28 V power source which permits use of standard cigar lighter adaptor plug.

2-1-4 INSTALLATION EQUIPMENT

None required; all electrical connections required to ready instrument for operation can be easily made by hand, without use of any special tools.

2-2 INSTALLATION PROCEDURE

POSITIONING TEST SET

1. Lift test set from shipping container and remove all packing material, tape etc. from set.

2. Extend support bracket on bottom of set to full locked position and place set on flat surface, bottom side down. (Bottom side of set has four plastic feet.)

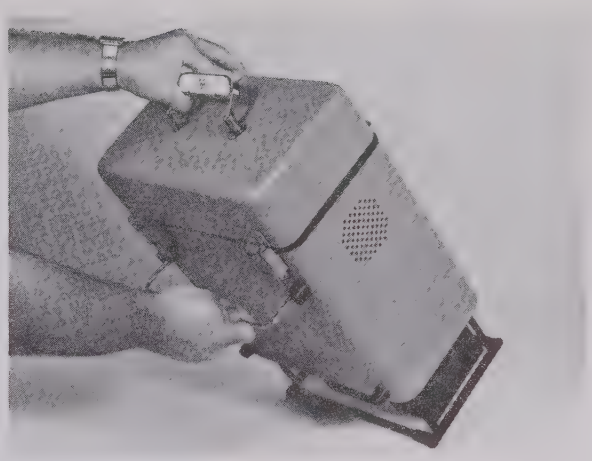


FIGURE 2-1 EXTENDING FM/AM-1000S/A SUPPORT BRACKETS

3. This is the most common operating position for the set when working on a bench or table. During mobile operation, set can be operated in an upright position, while resting on its metal support rails.

   Unlatch and fold back lid, exposing front panel face of test set. (If desired, lid can be detached from set at hinges by sliding lid to operator's right.)

FIGURE 2-2 FM/AM-1000S/A OPERATING POSITION

REMOVING SET ACCESSORIES

4. Remove retaining plate inside lid by rotating both quick-release latches counter-clockwise (ccw) and gently pulling plate straight out from lid.

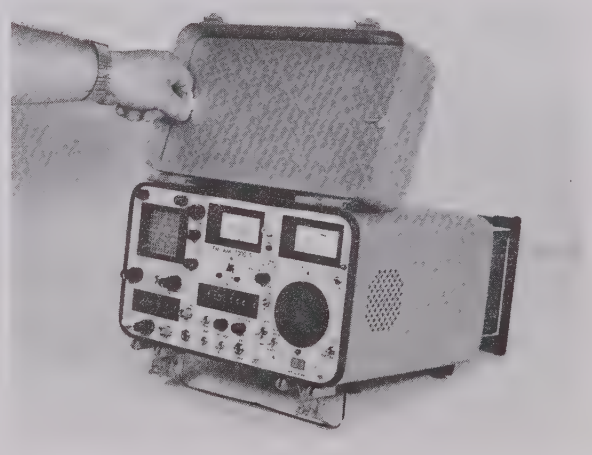


FIGURE 2-3 REMOVING LID RETAINING PLATE

5. Remove AC and DC power cables from inside of lid, along with 90° BNC connector. Note additional accessories attached to rear side of retaining plate removed in Step 4. Those accessories include:

   3 Spare Fuses
   1 Antenna
   1 Allen Wrench

   (See Appendix B for detailed list of FM/AM-1000S/A standard/ optional accessories.)

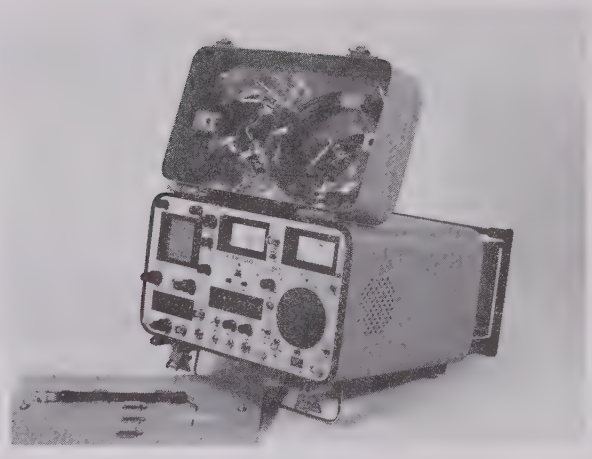


FIGURE 2-4 REMOVING FM/AM-1000S/A ACCESSORIES

CONNECTING ANTENNA

6. For "off-the-air" testing, antenna must be connected to ANT INPUT Connector (44) on front panel of test set. If test set is to be operated in an upright position, connect antenna directly to ANT INPUT Connector (44). If set is to rest on its support bracket during operation, attach antenna to furnished 90° BNC connector, then attach antenna/90° BNC connector assembly to ANT INPUT Connector (44).

CAUTION

- If an external antenna attached to an unterminated coax cable is used, remove any possible static charge buildup before connecting coax to ANT INPUT Connector. See procedure at right.

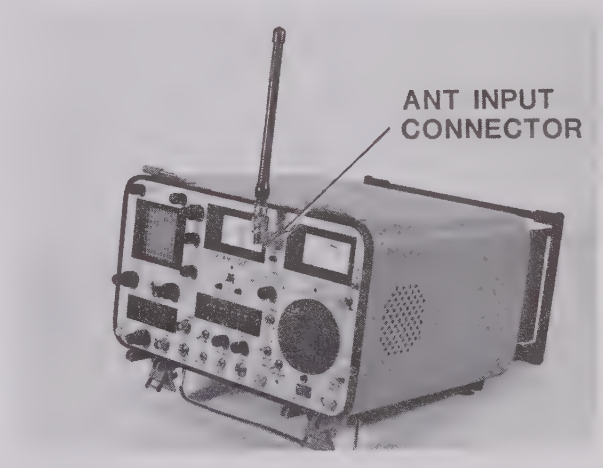


FIGURE 2-5 FM/AM-1000S/A WITH ANTENNA ATTACHED

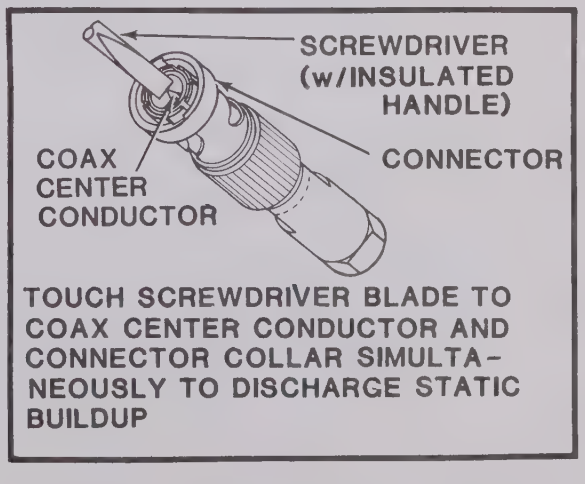


FIGURE 2-6 DISCHARGING STATIC BUILDUP FROM ANTENNA COAX

7. Determine source of power to be used to energize test set and proceed accordingly:

CAUTION

- When test set is powered from a vehicle's DC supply, make sure PWR/OFF/BATT Switch (9) is not in "PWR" position, while starting engine or blown fuse may result.

a. AC or DC POWER
   (1) Connect 6-pin socket on end of furnished AC (or DC) power cable to 6-pin external power receptacle on rear of test set.

   (2) If set is to be operated on AC power, make sure 115/230 VAC Power Select Switch is set to the appropriate position to accommodate the available power source. (For location of 115/230 VAC Power Select Switch, see Figure 3-5, page 3-12.)

   (3) Connect 3-pin grounded plug on opposite end of AC power cable to standard 3-pin grounded receptacle. (For DC operation, connect cigar lighter adaptor on opposite end of DC power cable to cigar lighter socket.)

   (4) Place PWR/OFF/BATT Switch (9) to "PWR" position to energize set.

b. BATTERY OPERATION
   (1) No power cable connections required; place PWR/OFF/BATT Switch to "BATT" position to energize set.

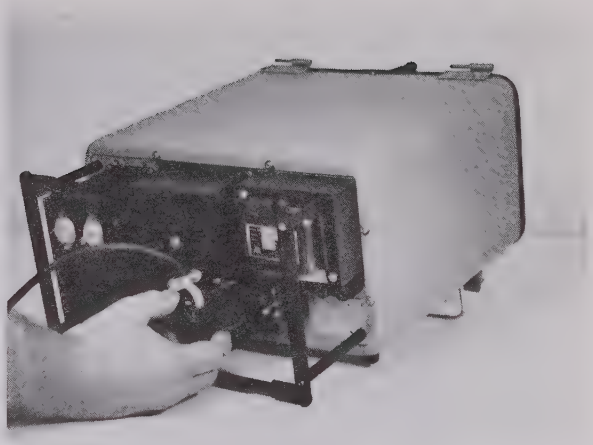


FIGURE 2-7 CONNECTING EXTERNAL AC OR DC POWER CABLE TO FM/AM-1000S/A

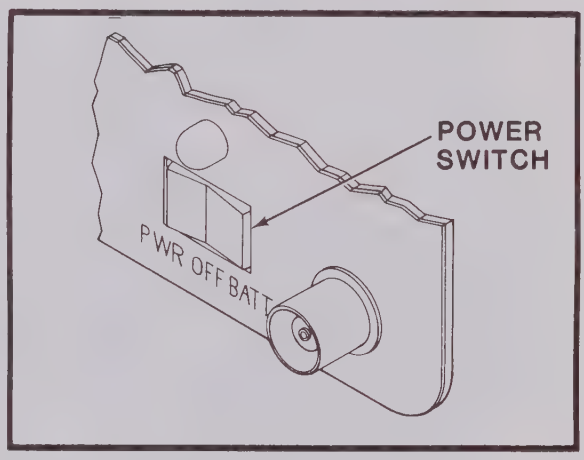


FIGURE 2-8 FM/AM-1000S/A POWER SWITCH

SECTION 3 - DESCRIPTION OF CONTROLS, CONNECTORS & INDICATORS

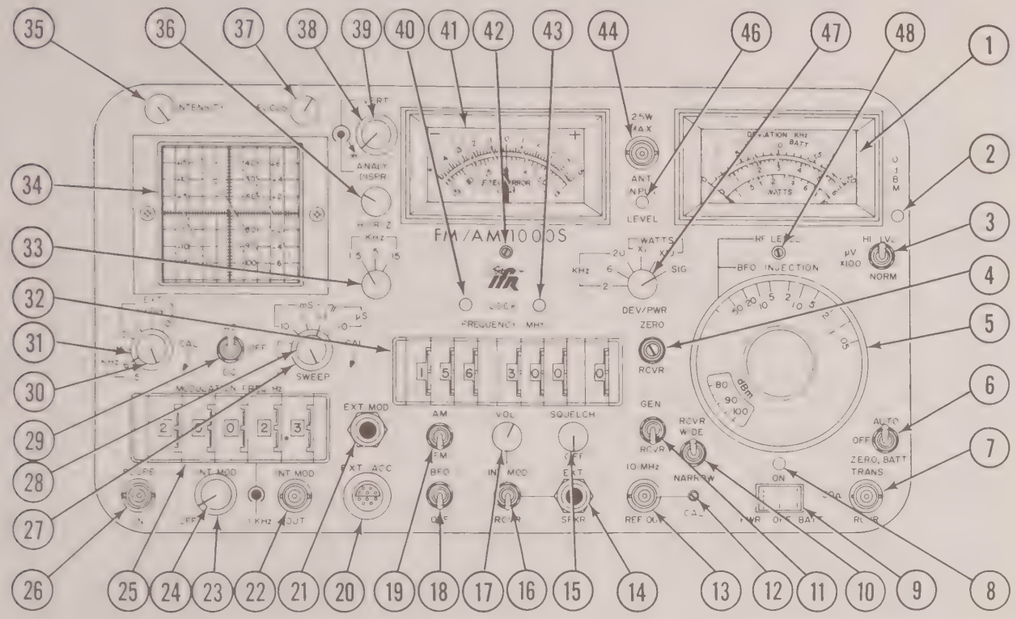


FIGURE 3-1 FM/AM-1000S FRONT PANEL

(FM/AM-1000A front panel is identical to FM/AM-1000S front panel with exception of CRT Display (34) markings and absence of item (39).)

1 DEVIATION/WATTS Meter
2 O dBm Lamp
3 HI LVL/µV X 100/NORM Switch
4 ZERO RCVR Adjustment
5 RF LEVEL/BFO INJECTION Dial
6 AUTO/OFF/ZERO, BATT Switch
7 TRANS/RCVR Connector
8 Power ON Lamp
9 PWR/OFF/BATT Switch
10 RCVR WIDE/MID/NARROW Switch
11 GEN/RCVR Switch
12 10 MHz CAL Adjustment
13 10 MHz REF OUT Connector
14 EXT SPKR Connector
15 SQUELCH Control
16 INT MOD/RCVR Switch
17 VOL Control
18 BFO/OFF Switch
19 AM/FM Switch
20 EXT ACC Connector
21 EXT MOD Connector
22 INT MOD OUT Connector
23 INT MOD Control
24 1 kHz INT MOD Control
25 MODULATION FREQ Hz Thumbwheels
26 SCOPE IN Connector
27 SWEEP Control
28 SWEEP Vernier Control
29 AC/OFF/DC Switch
30 EXT V/DIV Vernier Control
31 EXT V/DIV Control
32 FREQUENCY MHz Thumbwheels
33 1.5/5/15 kHz Control
34 CRT Display
35 INTENSITY Control
36 HORIZ Control
37 FOCUS Control
38 VERT Control
39 ANALY DISPR Control (FM/AM-1000S models only)
40 High Frequency LOCK Lamp
41 FREQ ERROR Meter
42 FREQ ERROR Meter Zero Adjustment
43 Low Frequency LOCK Lamp
44 ANT INPUT Connector
45 NOT USED
46 INPUT LEVEL Lamp
47 DEV/PWR Control
48 DEVIATION/WATTS Meter Zero Adjustment

Item	Name	Description

1. DEVIATION/WATTS Meter
Provides visual display of peak FM deviation, transmitter output power, transmitter signal strength (as received at ANT INPUT Connector (44)) and internal battery charge condition.

2. O dBm LAMP
Illuminates when FM/AM-1000S/A RF signal output is at O dBm or above.

3. HI LVL/µV X 100/NORM Switch
Three-position switch which selects power range for RF LEVEL/BFO INJECTION Dial (5) as follows:

"NORMAL" position - RF/BFO output level is equal to setting of RF LEVEL/BFO INJECTION Dial (5) on "µV" or "dBm" scale.

"µV X 100" position - RF/BFO output level is 100 times the RF LEVEL/BFO INJECTION Dial (5) setting on the "µV" scale. (Equivalent level in dBm is equal to reading of dBm scale, plus 40 dB.)

"HIGH LEVEL" position - Enables RF output levels above -35 dBm to be achieved.

4. ZERO RCVR Adjustment
Adjustment screw for zeroing FREQ ERROR Meter (41) when FM/AM-1000S/A power is "ON." (GEN/RCVR Switch (11) must be in "GEN" position when zeroing meter.)

5. RF LEVEL/BFO INJECTION Dial
Controls FM/AM-1000S/A RF output level when set is operating in signal generator mode and BFO (beat frequency oscillator) injection level when set is operating in receiver mode. Control knob contains scales for reading power levels in both "µV" (microvolts) and "dBm" (decibels per milliwatt).

6. AUTO/OFF/ZERO, BATT Switch
Three-position switch which activates/deactivates auto-zeroing circuit and provides a visual indication of internal battery voltage condition as follows:

"AUTO" position - Auto-zeroing circuit is activated, automatically zeroing receiver and FREQ ERROR Meter (41) through an internal self-check.

"OFF" position - Auto-zeroing circuit is deactivated.

Item	Name	Description

6. AUTO/OFF/ZERO, BATT Switch (cont'd)

"BATT" position - When switch is held in this springloaded position, a visual indication of internal battery voltage condition is displayed on DEVIATION/WATTS Meter (1). Battery is discharged when DEVIATION/WATTS Meter (1) reads 11 volts under load; FM/AM-1000S/A will turn off automatically when this condition occurs.

NOTE

- When activated, auto-zeroing reference pulse will cause minor CRT trace and meter meedle deflections to occur; this is a normal operating condition and should be disregarded.

- With auto-zeroing circuit activated, a 3 ms void will be produced by reference pulse every 1.5 seconds in generate/receive modes. If this condition hinders testing of UUT (Unit Under Test), place switch to "OFF" position. In "OFF" position, FREQ ERROR Meter (41) is not calibrated and should not be used for frequency error measurements.

7. TRANS/RCVR Connector
50Ω RF input/output connector for UUT.

CAUTION

- DO NOT APPLY MORE THAN 20 WATTS OF CONTINUOUS INPUT TO TRANS/RCVR CONNECTOR. Maximum "ON" time for measurement of transmitter output using TRANS/RCVR Connector is:

10 seconds at 100 W, 15% Duty Cycle
20 seconds at 50 W, 30% Duty Cycle
2 minutes at 30 W, 50% Duty Cycle

8. Power ON Lamp
Illuminates when power is applied to FM/AM-1000S/A.

9. PWR/OFF/BATT Switch
Three-position rocker switch which supplies/interrupts power to FM/AM-1000S as follows:

"PWR" (Leftmost position) - Applies external AC or DC power to FM/AM-1000S/A.

Item	Name	Description

9. PWR/OFF/BATT Switch (cont'd)

"OFF" (Center position) - Shuts off power to all FM/AM-1000S/A circuits, except battery charger circuit.

"BATT" (Rightmost position) - Powers FM/AM-1000S/A by its internal battery; set will turn off automatically after approximately eight minutes of operation, to prevent battery rundown.

NOTE

- FM/AM-1000S/A internal battery is charged whenever set is connected to an AC power source, including when power switch is "OFF."

10. RCVR WIDE/MID/NARROW Switch
Selects "WIDE", "MID" or "NARROW" bandwidth of FM/AM-1000S/A receiver.

11. GEN/RCVR Switch
Controls operating mode of FM/AM-1000S/A as a signal generator or receiver as follows:

"GEN" position - FM/AM-1000S/A functions as a signal generator, producing RF output at TRANS/RCVR Connector (7). If RF energy is applied to this connector (7) while set is in generator mode, set will automatically switch to receiver mode.

"RCVR" position - FM/AM-1000S/A functions as a receiver. Signal input (0.1 watt minimum required) may be direct through the TRANS/RCVR Connector (7) or "off-the-air" via an external antenna attached to ANT INPUT Connector (44).

12. 10 MHZ CAL Adjustment
Fine tuning adjustment for FM/AM-1000S/A 10 MHz master oscillator frequency.

13. 10 MHz REF OUT Connector
10 MHz master oscillator output connector.

14. EXT SPKR Connector
Audio output connector for remote speaker, headphones etc.

Item	Name	Description

15. SQUELCH Control
Squelch threshold adjustment; squelch disables audio output when RF input at ANT INPUT Connector (44) falls below squelch threshold.

NOTE

- SQUELCH Control is "OFF" when fully ccw in detent position. When out of detent position, rotate control cw to increase squelch threshold or ccw to decrease threshold. (The greater the squelch threshold, the greater the signal input required to break the threshold.)

16. INT MOD/RCVR Switch
Couples FM/AM-1000S/A receiver or dual tone generator audio output to FM/AM-1000S/A internal speaker.

17. VOL Control
Controls audio output level of FM/AM-1000S/A internal speaker (or external accessory speaker when connected to EXT SPKR Connector (14)).

18. BFO/OFF Switch
Activates or deactivates FM/AM-1000S/A internal beat frequency oscillator (BFO).

19. AM/FM Switch
Selects signal mode to be generated or received by FM/AM-1000S/A as follows:

"AM" position - FM/AM-1000S/A generates or receives amplitude modulated (AM) signals.

"FM" position - FM/AM-1000S/A generates or receives frequency modulated (FM) signals.

20. EXT ACC Connector
Output connector providing power or signal sources for external accessory equipment. (See Appendix F for connector pin assignments.)

21. EXT MOD Connector
Input connector for external modulation sources. (See Appendix F for connector contact assignments.)

22. INT MOD OUT Connector
Output connector which couples dual tone generator audio output to external devices. Output level is controlled by INT MOD Control (23) and 1 kHz INT MOD Control (24).

Item	Name	Description

22. INT MOD OUT Connector (cont'd)

NOTE

- Output can consist of one or any combination of following modulated signals mixed together:

  1 kHz INTERNAL MODULATION
  VARIABLE INTERNAL MODULATION
  EXTERNAL MODULATION

23. INT MOD Control
Controls %AM modulation or FM peak deviation of frequency selected on MODULATION FREQ Hz Thumbwheels (25). Modulation control is "OFF" in full ccw, detent position; when out of detent, rotate control cw to increase modulation level.

NOTE

- Modulated frequency can be externally keyed through the EXT MOD Connector (21).

24. 1 kHz INT MOD Control
Controls %AM modulation or FM peak deviation for an approximate 1 kHz tone. Modulation control is "OFF" in full ccw detent position; when out of detent, rotate control cw to increase modulation level.

25. MODULATION FREQ Hz Thumbwheels
Select internal modulation frequency produced by dual tone generator (10.0 Hz through 9999.9 Hz).

26. SCOPE IN Connector
Vertical deflection input for oscilloscope.

CAUTION

- DO NOT APPLY MORE THAN 200 VOLTS (PEAK-TO-PEAK) TO THIS CONNECTOR.

27. SWEEP Control
Controls horizontal sweep speed of oscilloscope in indicated millisecond or microsecond increments per graticule division.

28. SWEEP Vernier Control
Permits continuous variation of sweep speed within any of the ranges provided by SWEEP Control (27). In "CAL" position (fully cw, detent), oscilloscope horizontal graticule divisions are equal to setting of SWEEP Control.

Item	Name	Description

28. SWEEP Vernier Control (cont'd)

NOTE

- Do not make time measurements with SWEEP Vernier Control out of "CAL" position.

29. AC/OFF/DC Switch
Three-position switch which AC couples scope inputs in "AC" position, DC couples scope inputs in "DC" position and disconnects power from oscilloscope (and spectrum analyzer on FM/AM-1000S models) in "OFF" position.

NOTE

- When switching from one coupling mode to another, pause briefly in "OFF" position; this ensures that scope power supply inverter will start.

- To conserve power during battery operation, place coupling switch to "OFF" when oscilloscope or spectrum analyzer are not in use.

30. EXT V/DIV Vernier Control
Permits variation of oscilloscope vertical sensitivity within any of the ranges provided by EXT V/DIV Control (31). In "CAL" position (fully cw detent), oscilloscope vertical graticule divisions are equal to setting of EXT V/DIV Control (31).

NOTE

- Do not make voltage mesurements with EXT V/DIV Vernier Control out of "CAL" position.

31. EXT V/DIV Control
Controls oscilloscope vertical sensitivity and input source applied to oscilloscope as follows:

"EXT V/DIV" positions - Selects oscilloscope vertical sensitivity (in indicated voltage increments per graticule division) for signals applied to SCOPE IN Connector (26).

"kHz" positions - Oscilloscope displays frequency deviation (in "FM" mode) or modulation envelope (in "AM" mode).

31. EXT V/DIV Control (cont'd)

EXAMPLE: (Reference CRT display below.)
If EXT V/DIV Switch is positioned to 15 or 1.5 kHz setting, measured full scale frequency deviation is 15 kHz or 1.5 kHz along scale "A." If switch is positioned to 6 kHz setting, measured full scale frequency deviation is 6 kHz along scale "B".

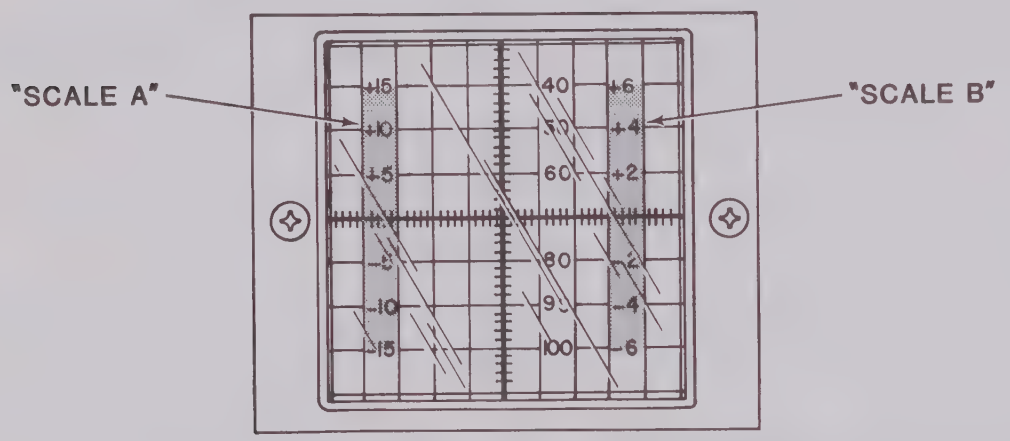


FIGURE 3-2 CRT DISPLAY DEVIATION SCALES (FM/AM-1000S CRT DISPLAY SHOWN)

NOTE

- When viewing modulation envelope in "AM" mode, setting of EXT V/DIV Control in "kHz" range is irrelevant.

32. FREQUENCY Hz Thumbwheels
Select signal generator or receiver frequency.

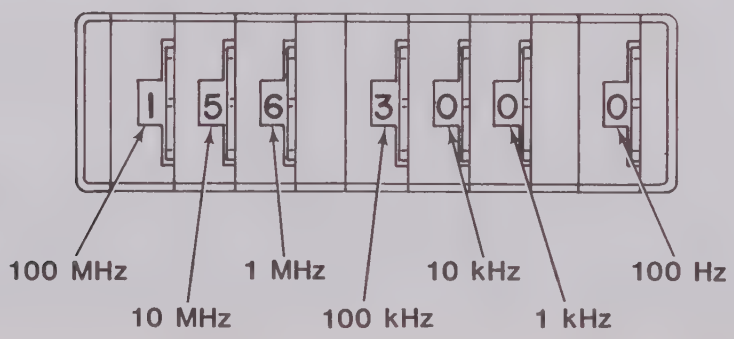


FIGURE 3-3 FREQUENCY MHz THUMBWHEELS

33. 1.5/5/15 kHz Control
Selects full scale sensitivity of "FREQUENCY ERROR METER" (41).

34. CRT Display
Display screen for FM/AM-1000S/A oscilloscope and FM/AM-1000S oscilloscope/spectrum analyzer functions.

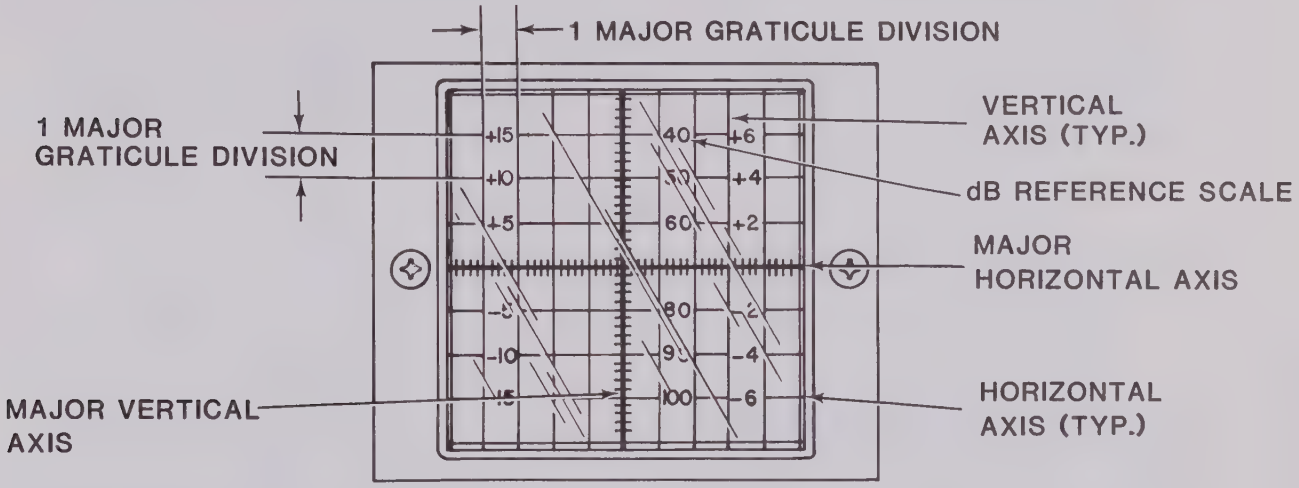


FIGURE 3-4 CRT DISPLAY GRATICULE MARKINGS (FM/AM-1000S MODEL SHOWN)

NOTE

- The FM/AM-1000A CRT Display does not have markings for the dB REFERENCE SCALE.

35. INTENSITY Control
Controls brightness of CRT trace. Rotate control ccw to decrease brightness, cw to increase brightness.

CAUTION

- When applying power to oscilloscope or spectrum analyzer through PWR/OFF/BATT Switch (9) or AC/OFF/DC Switch (29), make sure INTENSITY Control (35) is turned to a moderate intensity level.

  Warm-up time of CRT is approximately 30 seconds from a "cold" start-up; trace display will not become visible until CRT achieves warm-up.

36. HORIZ Control
Controls horizontal position of oscilloscope trace. Rotate control cw to move trace to right, ccw to move trace to left.

37. FOCUS Control
Controls sharpness of oscilloscope trace.

Item	Name	Description

38. VERT Control
Controls vertical position of oscilloscope trace. Rotate control cw to move trace up, ccw to move trace down.

39. ANALY DISPR Control (Present on FM/AM-1000S models only)
Continuously varies spectrum analyzer dispersion within a span of 1 to 10 MHz. Full cw rotation of control provides a dispersion of 1 MHz per major graticule division; full ccw rotation (short of detent position) provides a dispersion of 0.1 MHz per major graticule division. In full ccw detent position, spectrum analyzer is "OFF" and oscilloscope is "ON."

NOTE

- During FM/AM-1000S spectrum analyzer operation, all oscilloscope controls except INTENSITY Control (35), FOCUS Control (37) and AC/OFF/DC Switch (29) are disabled. Spectrum Analyzer can be turned "OFF" using AC/OFF/DC Switch (29).

40. High Frequency Phase LOCK Light
When illuminated, indicates proper operation of High Frequency Phase Lock Board in FM/AM-1000S/A. Light will "blink" momentarily when "MHz" segments of FREQUENCY MHz Thumbwheels (32) are incremented or decremented, however light should remain illluminated at all other times when FM/AM-1000S/A power is "ON."

41. FREQ ERROR Meter
Provides visual display of difference between received signal frequency and FM/AM-1000S/A receiver frequency (as represented by FREQUENCY MHz Thumbwheel (32) setting).

42. FREQ ERROR Meter Zero Adjustment
Mechanical zero adjustment of FREQ ERROR Meter (41) intended for use when power to FM/AM-1000S/A is "OFF."

43. Low Frequency Phase LOCK Light
When illuminated, indicates proper operation of 79-80 MHz Low Frequency Phase Lock Board in FM/AM-1000S/A. Light will "blink" momentarily when "kHz" and "Hz" segments of FREQUENCY MHz Thumbwheels (32) are incremented or decremented, however light should remain illuminated at all other times when FM/AM-1000S/A power is "ON."

44. ANT INPUT CONNECTOR
External antenna input to FM/AM-1000S/A, used primarily for "off-the-air" testing.

Item	Name	Description

44. ANT INPUT Connector (cont'd)

CAUTION

- MAXIMUM CONTINUOUS INPUT ANT INPUT CONNECTOR MUST NOT EXCEED .25 W.
- ON FM/AM-1000S MODELS, MAXIMUM INPUT TO ANT INPUT CONNECTOR IS -30 dBm FOR PROPER SPECTRUM ANALYZER OPERATION. (Signals above -30 dBm may cause spurious signals to be generated and displayed by FM/AM-1000S Spectrum Analyzer.)
- IF AN EXTERNAL ANTENNA ATTACHED TO AN UNTERMINATED COAX CABLE IS USED, REMOVE ANY POSSIBLE STATIC CHARGE FROM ANTENNA COAX BEFORE CONNECTING TO FM/AM-1000S/A.

45. NOT USED

46. INPUT LEVEL Lamp
When illuminated, indicates input level at ANT INPUT Connector (44) is above squelch threshold of FM/AM-1000S/A receiver.

47. DEV/PWR Control
Selects ranges for peak FM frequency deviation, input power at TRANS/RCVR Connector (7) and received signal strength as follows:

"kHz" positions - Selects full scale range for peak FM deviation as displayed by DEVIATION/WATTS Meter (1).

"WATTS" positions - Selects multiplier for output power measurements on red "WATTS" scale of DEVIATION/WATTS Meter (1).

"SIG" position - For signals received "off-the-air", a qualitative respresentation of relative signal strength can be determined by observing DEVIATION/WATTS Meter (1) needle deflection. As signal strength increases, the meter needle deflection will increase towards right of meter scale.

48. DEVIATION/WATTS Meter Zero Adjustment
Mechanical zero adjustment of DEVIATION/WATTS Meter intended for use when FM/AM-1000S/A power is "OFF."

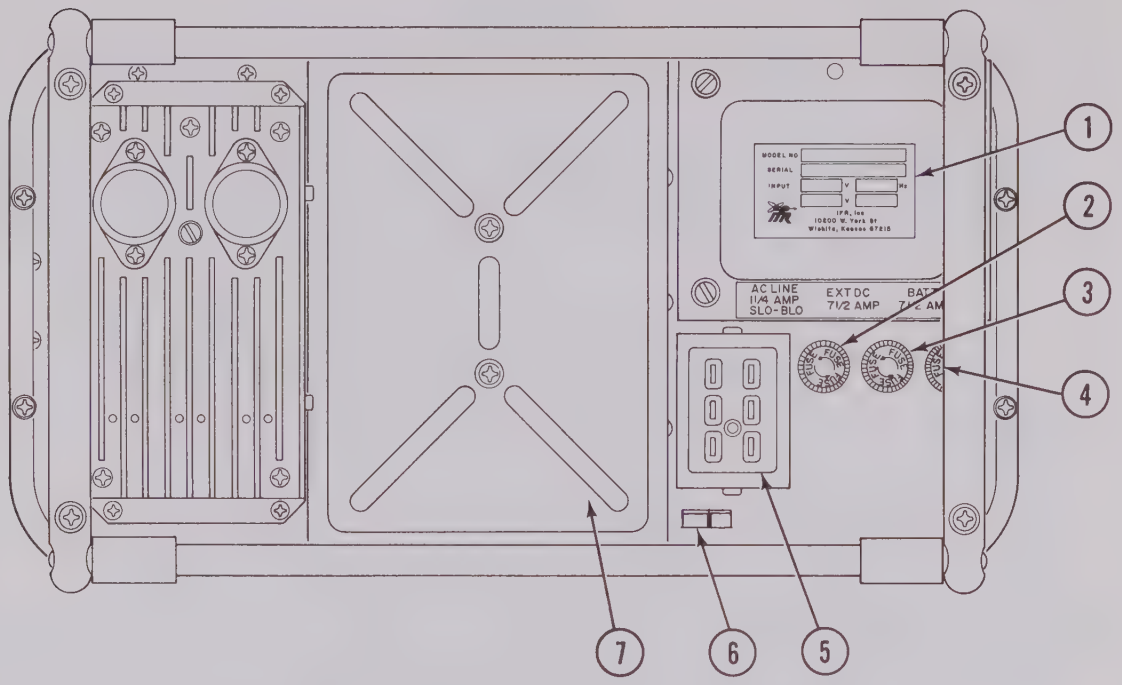


FIGURE 3-5 FM/AM-1000S/A REAR PANEL

ITEM	NAME	DESCRIPTION
1.	SERIAL NO. NAMEPLATE	
2.	AC LINE FUSE	1¼ Amp. SLO BLO fuse.
3.	EXTERNAL DC FUSE	7½ Amp. fuse.
4.	BATTERY FUSE	7½ Amp. fuse.
5.	6-PIN EXTERNAL POWER RECEPTACLE	
6.	115/230 VAC POWER SELECT SWITCH	Two position slide switch which enables FM/AM-1000S/A to be operated on 115 or 230 VAC external power, whichever is selected.
7.	BATTERY HOUSING	

SECTION 4 - OPERATION

4-1 GENERAL

This section contains operating instructions relating to all major functions of the FM/AM-1000S/A and is divided into the following two major subsections:

BASIC FUNCTIONAL OPERATING PROCEDURES

Section	Title
4-2	Test Procedures Using FM/AM-1000S/A Oscilloscope
4-3	Test Procedures Using FM/AM-1000S Spectrum Analyzer (Applies only to FM/AM-1000S models)
4-4	Test Procedures Using FM/AM-1000S/A Dual Tone Generator
4-5	Test Procedures Using FM/AM-1000S/A RF Generator
4-6	Test Procedures Using FM/AM-1000S/A Receiver
4-7	Test Procedures Using FM/AM-1000S/A as a Sweep Generator/Tracking Oscilloscope.

GENERAL RECEIVER/TRANSMITTER TESTS

Section	Title
4-8	General Receiver Tests
4-9	General Transmitter Tests

For purposes of clarity and ease of understanding, all instructions are presented as individual test procedures conforming to a "step by step" format. The procedures included within each section are those most commonly associated with the various functions of the FM/AM-1000S/A and AM/FM transceiver testing.

Each group of "BASIC FUNCTIONAL OPERATING PROCEDURES" is preceded by a brief introductory paragraph relating to the particular FM/AM-1000S/A function to be used, followed by a table containing FM/AM-1000S/A initial control settings required for use of that function. Each individual test procedure in turn (including those under "GENERAL RECEIVER/TRANSMITTER TESTS"), contains the following common headings:

4-2-1	Test procedure number.
TEST PROCEDURE:	Name of procedure to be performed.
TEST OBJECTIVE:	Purpose or intent of procedure; if name of "TEST PROCEDURE" itself implies test objective, this heading will contain N/A (not applicable).
SPECIAL ACCESSORY EQUIPMENT REQ'D:	List of any special accessory test equipment required to support procedure, beyond FM/AM-1000S/A and UUT.
TEST SET-UP DIAGRAM:	A diagrammatic aid to operator in making proper connections between FM/AM-1000S/A, UUT and special accessory equipment.

4-1 GENERAL (CONT'D)

NOTE

- Those procedures bearing the the symbol MM-100 on the upper right hand corner of the page, can be more easily performed using the MM-100 Multi-Meter option. If your FM/AM-1000S/A is so equipped, refer to MM-100 Operation Manual for the corresponding procedure.

4-1-1 PRE-OPERATIONAL CONSIDERATIONS

For maximum benefit of all operating procedures contained herein, it is strongly recommended that operator:

1. Thoroughly read and understand all steps of procedure to be performed, prior to its completion.

2. Be familiar with the circuit or unit under test so some idea is perceived as to the voltage, frequency and waveform to be expected at each test point. This knowledge will aid operator in performing the test procedure in a logical efficient manner with a minimum of blind searching.

4-1-2 OPERATING PRECAUTIONS

In addition to the general safety precautions listed under Section 2-1-1 of this manual, the operator must observe the following additional operating precautions:

1. When working with "live" circuits of high potential, keep one hand in pocket or behind back to avoid serious shock hazard.

2. Remove all jewelry or other cosmetic apparel before performing any test procedures involving "live" circuits.

3. Use only insulated troubleshooting tools when working with "live" circuits.

4. For added insulation, place rubber bench mat underneath all powered bench equipment, as well as a rubber floor mat underneath operator chair.

5. Heed all WARNINGS and CAUTIONS concerning maximum voltage and power inputs.

6. Avoid using oscilloscope/spectrum analyzer in direct sunlight, as scope trace is difficult to see under these conditions.

7. Do not allow scope trace to become concentrated on CRT as a stationary spot, as CRT screen may be burned permanently. Reduce trace intensity if trace must remain stationary.

8. Protect FM/AM-1000S/A from vibration or mechanical shock. The CRT of the FM/AM-1000S/A is highly evacuated and if broken, will implode causing possible serious injury from fragmented glass.

4-2 TEST PROCEDURES USING FM/AM-1000S/A OSCILLOSCOPE

4-2-1 GENERAL

The FM/AM-1000S/A contains a 1 MHz oscilloscope designed for use as a general purpose diagnostic tool. The operator can use this instrument to observe or measure such signal characteristics as AC/DC voltage level, waveshape, pulse duration, pulse spacing and frequency. Additional features unique to this oscilloscope include the selectability of two sweep sources (internal saw-tooth generator and dual tone generator) and the ability to monitor both AM and FM signal modulation.

The procedures contained in this section are:

4-2-3 MEASURING DC VOLTAGES
4-2-4 MEASURING PEAK-TO-PEAK VOLTAGES
4-2-5 MEASURING RMS AC VOLTAGES (Sine Wave Only)
4-2-6 MEASURING PEAK AC VOLTAGES
4-2-7 MEASURING FREQUENCIES BETWEEN 5 kHz AND 500 kHz
4-2-8 MEASURING PULSE DURATION AND DUTY CYCLE

4-2-2 INITIAL FM/AM-1000S/A CONTROL SETTINGS FOR OSCILLOSCOPE OPERATION

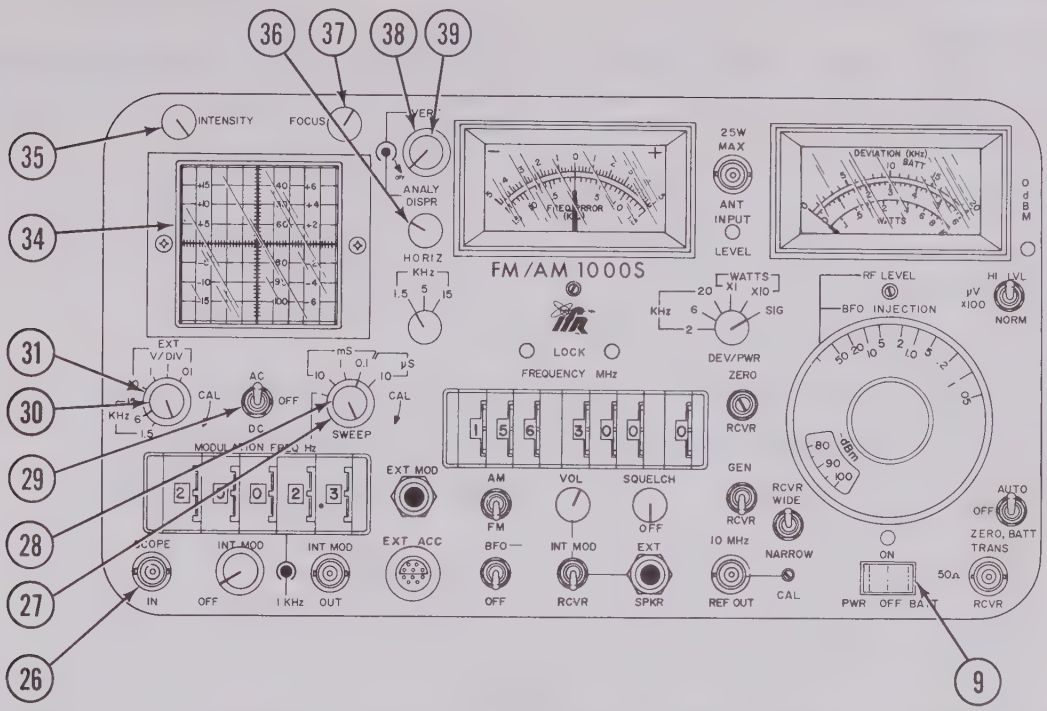


FIGURE 4-1 FM/AM-1000S/A CONTROLS APPLICABLE TO OSCILLOSCOPE OPERATION

(Refer to "SECTION 3 - DESCRIPTION OF CONTROLS, CONNECTORS & INDICATORS" for functional description of any controls used in this section.)

NOTE

- Before performing any procedures contained in this section pertaining to oscilloscope operation, make sure all applicable test set controls are positioned as outlined below.
- Some of the control settings outlined below may be changed during the course of a given procedure; all controls, however, should be reset to initial positions described below when starting a new procedure.

	CONTROL	INITIAL SETTING
9	PWR/OFF/BATT Switch	"OFF" position
27	SWEEP Control	"1ms" position
28	SWEEP Vernier Control	Fully cw, detent (in "CAL" position)
29	AC/OFF/DC Switch	"DC" position
30	EXT V/DIV Vernier Control	Fully cw, detent (in "CAL" position)
31	EXT V/DIV Control	"10 V/DIV" position
35	INTENSITY Control	Midrange position
36	HORIZ Control	Midrange position

4-2-2 INITIAL FM/AM-1000S/A CONTROL SETTINGS FOR OSCILLOSCOPE OPERATION (CONT'D)

	CONTROL	INITIAL SETTING
37	FOCUS Control	Midrange position
38	VERT Control	Midrange position
39	ANALY DISPR Control (FM/AM-1000S only)	Fully ccw, detent

Other FM/AM-1000S/A features related to oscilloscope operation but not requiring an initial setting:

26 SCOPE IN Connector
34 CRT Display

The FM/AM-1000S/A is now ready for oscilloscope operation.

4-2-3

TEST PROCEDURE: ***MEASURING DC VOLTAGES***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for general oscilloscope operation as shown in Figure 4-1, page 4-5.
2.	Apply power to FM/AM-1000S/A.
3.	Apply power to UUT.
4.	Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately to obtain a sharp visible trace display.

NOTE

- Warm-up time of CRT is approximately 30 seconds from a "cold" start-up; trace display will not become visible until CRT achieves warm-up.

5. Adjust VERTICAL Control (38) and HORIZ Control (36) to center scope trace over major horizontal axis of CRT.

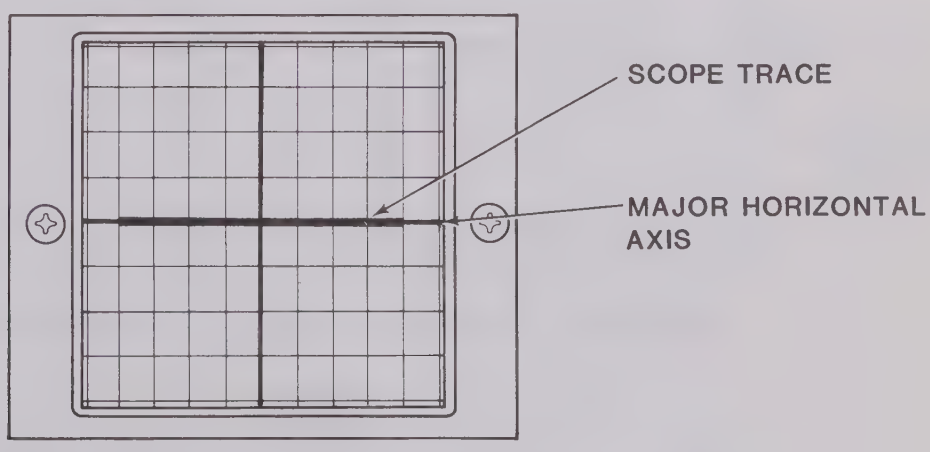


FIGURE 4-2 SCOPE TRACE CENTERED OVER MAJOR HORIZONTAL AXIS

STEP PROCEDURE

6. Apply signal to be measured to SCOPE IN Connector (26) using a scope probe or coax. If a scope probe is used, make sure ground lead is attached to UUT ground.

CAUTION

- DO NOT APPLY MORE THAN 200 VOLTS (PEAK-TO-PEAK) TO SCOPE IN CONNECTOR (26).

7. Observe trace deflection in relation to major horizontal axis to which trace was previously aligned:

   a. If trace deflection is downward (towards bottom of CRT), voltage being measured is negative.

   b. If trace deflection is upward (towards top of graticule), voltage being measured is positive.

8. To determine voltage of signal:

   a. Count and record number of graticule divisions (along major vertical axis) from major horizontal axis to location where trace is now deflected (see examples below):

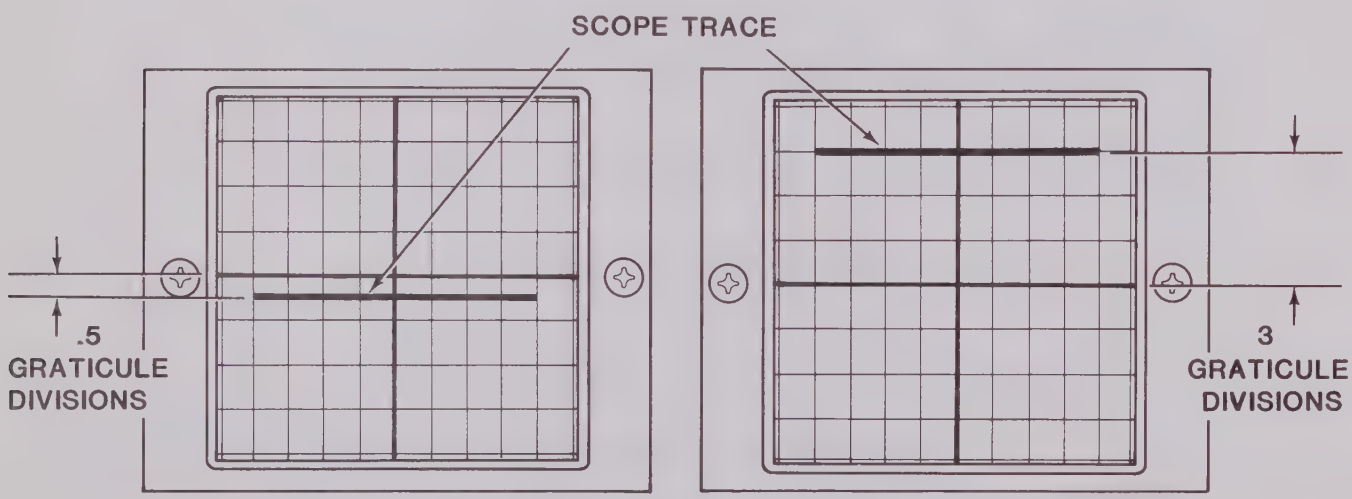


FIGURE 4-3 EXAMPLES OF DC VOLTAGE MEASUREMENTS

NOTE

- If trace deflection from major horizontal axis is to small to be accurately measured, adjust EXT V/DIV Control to next smaller volts/division setting. This should result in a greater trace deflection.

STEP	PROCEDURE

8. (cont'd)

b. Multiply result obtained in Step 8a by setting of EXT V/DIV Control (31):

Trace deflection in graticule divisions X Setting of EXT V/DIV Control = DC VOLTAGE

EXAMPLE: Trace deflection = 2.6 graticule divisions

EXT V/DIV Control Setting = .1 volts/division

(2.6) x (.1) = .26 volts DC

4-2-4

TEST PROCEDURE: ***MEASURING PEAK TO PEAK VOLTAGES***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for oscilloscope operation as shown in Figure 4-1, page 4-5.
2.	Place scope AC/OFF/DC Switch (29) to "AC" position.
3.	Apply power to FM/AM-1000S/A.
4.	Apply power to UUT.
5.	Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately to obtain a sharp visible trace display.

NOTE

- Warm-up time of CRT is approximately 30 seconds from a "cold" start-up; trace display will not become visible until CRT achieves warm-up.

6.	Adjust VERT Control (38) and HORIZ Control (36) to center scope trace over major horizontal axis of CRT.
7.	Apply signal to be measured to SCOPE IN Connector (26) using a scope probe or coax. If a scope probe is used, make sure ground lead is attached to UUT ground.

CAUTION

- DO NOT APPLY MORE THAN 200 VOLTS (PEAK-TO-PEAK) TO SCOPE IN CONNECTOR (26).

8.	Adjust SWEEP Control (27), EXT V/DIV Control (31) and SWEEP Vernier Control (28) to obtain a stable waveform display of signal to be measured.

STEP	PROCEDURE

8. (cont'd)

NOTE

- EXT V/DIV Vernier Control(30) must remain in "CAL" position (fully cw, detent).

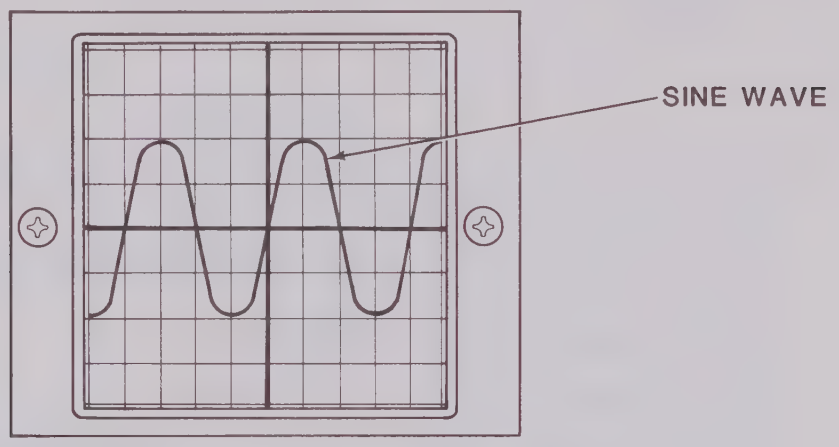


FIGURE 4-4 STABLE SINE WAVE DISPLAY

9. Adjust VERT Control (38) until negative peaks of waveform rest on any horizontal axis of scope display.

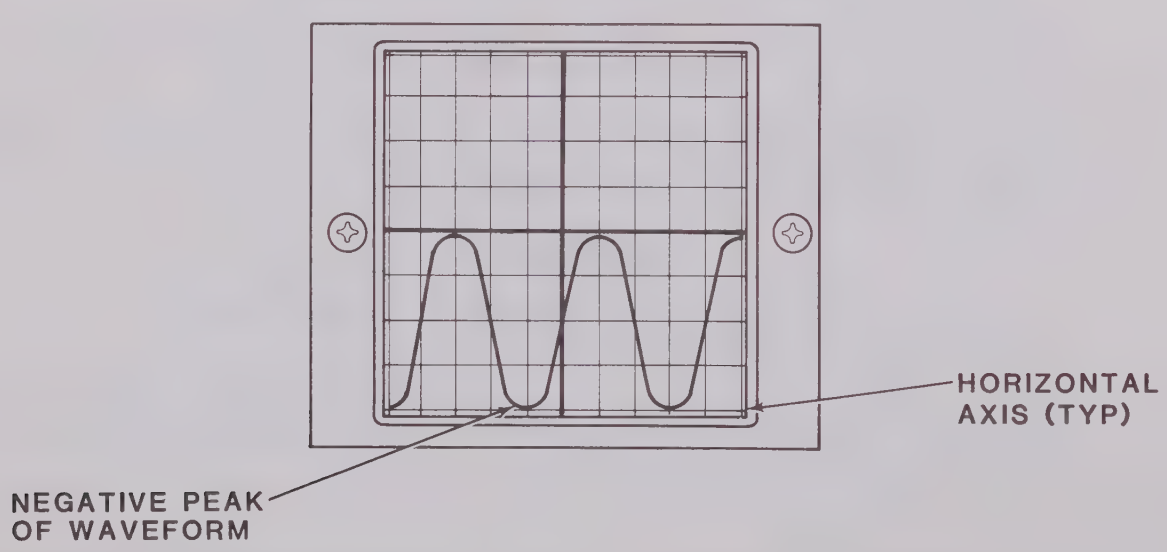


FIGURE 4-5 NEGATIVE PEAKS OF SINE WAVE RESTING ON HORIZONTAL AXIS

STEP PROCEDURE

10. Adjust HORIZ Control (36) to center positive peak of waveform over major vertical axis of CRT.

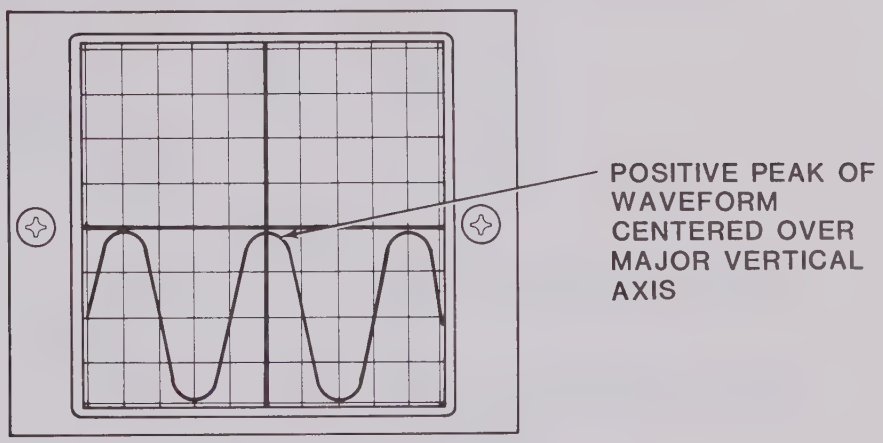


FIGURE 4-6 POSITIVE PEAK OF WAVEFORM CENTERED OVER MAJOR VERTICAL AXIS

11. Count number of graticule divisions between positive and negative peaks of waveform. Record this number.

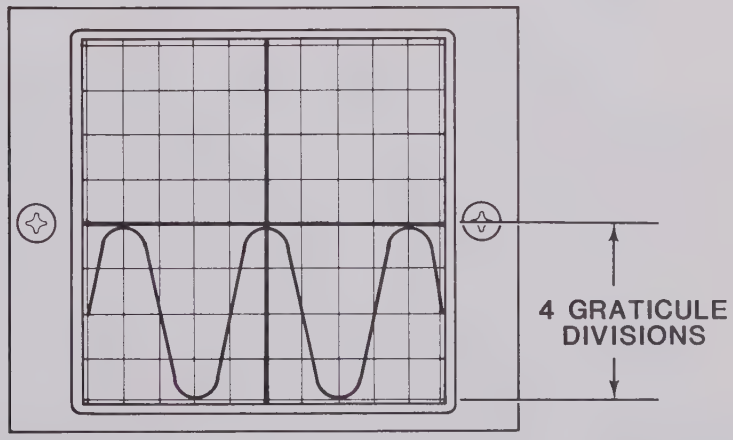


FIGURE 4-7 MEASURING PEAK-TO-PEAK AMPLITUDE OF WAVEFORM

12. Multiply result obtained in Step 9 by setting of EXT V/DIV Control (31):

No. of graticule divisions from negative to positive peak X Setting of EXT V/DIV Control = PEAK-TO-PEAK VOLTAGE

STEP	PROCEDURE
12.	(cont'd)

EXAMPLE: Graticule divisions from positive to negative peaks: 4.5

EXT V/DIV Control Setting = 1 VOLT/DIVISION

(4.5) X (1) = 4.5 VOLTS PEAK-TO-PEAK

TEST PROCEDURE: ***MEASURING RMS AC VOLTAGES (SINE WAVE ONLY)***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Perform procedure 4-2-4, titled "HOW TO MEASURE PEAK-TO-PEAK VOLTAGES", on page 4-11.
2.	Apply resultant peak-to-peak voltage to following equation:

$$\text{VOLTS}_{\text{RMS}} = \frac{Vp\text{-}p}{2} \times 0.707$$

EXAMPLE:

Peak-to-peak voltage obtained in Step 1 = 6.8 Volts

$$\text{VOLTS}_{\text{RMS}} = \frac{6.8}{2} \times 0.707$$

$$\text{VOLTS}_{\text{RMS}} = 3.4 \times 0.707$$

$$\text{VOLTS}_{\text{RMS}} = 2.4038$$

TEST PROCEDURE: ***MEASURING PEAK AC VOLTAGES***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Perform procedure 4-2-4, titled "HOW TO MEASURE PEAK-TO-PEAK VOLTAGES", on page 4-11.
2.	Divide resultant peak-to-peak voltage by two. The result of this step is the peak voltage (Vp).

TEST PROCEDURE: ***MEASURING FREQUENCIES BETWEEN 5 kHz AND 500kHz****

(* The frequency response of the FM/AM-1000S/A oscilloscope is 1 MHz. However, due to the resolution of the scope trace and the limitations of the sweep range, 500 kHz is the largest practical frequency that can be measured under this procedure.)

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: Calculator

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for general oscilloscope operation as shown in Figure 4-1, page 4-5.
2.	Place AC/OFF/DC Switch (29) to "AC" position.
3.	Apply power to UUT.
4.	Apply power to FM/AM-1000S/A.
5.	Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately to obtain a sharp visible trace display.

NOTE

- Warm-up time of CRT is appproximately 30 seconds from a "cold" start-up; trace display will not become visible until CRT achieves warm-up.

6.	Adjust VERT Control (38) and HORIZ Control (36) to center scope trace over major horizontal axis of CRT.
7.	Apply signal to be measured to SCOPE IN Connector (26) using a scope probe or coax. If a scope probe is used, make sure ground lead is attached to UUT ground.

CAUTION

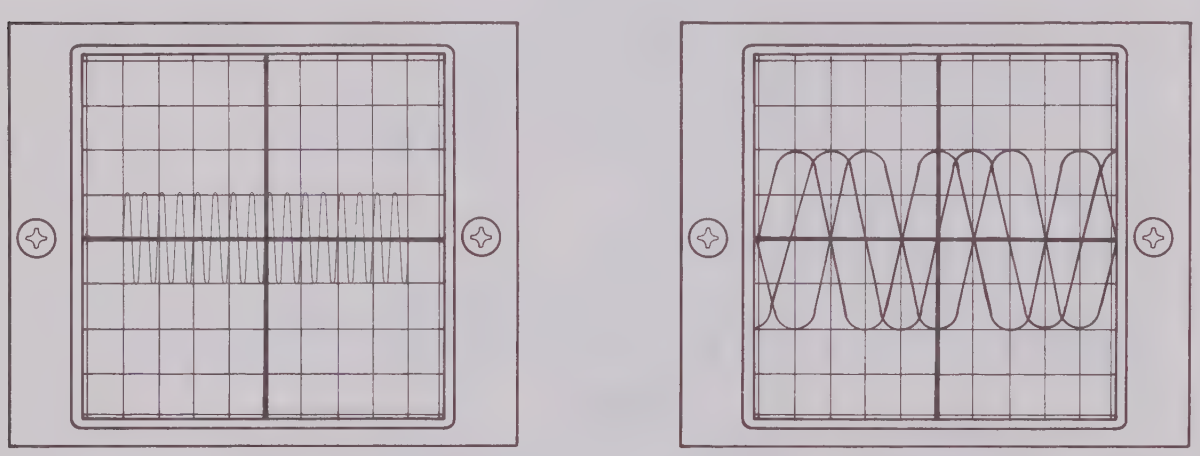
- DO NOT APPLY MORE THAN 200 VOLTS (PEAK-TO-PEAK) TO SCOPE IN Connector (26).

STEP PROCEDURE

8. Adjust SWEEP Control (27) and EXT V/DIV Control (31) to obtain a stable waveform display of signal being measured. EXT V/DIV Vernier Control (30) may also be adjusted to achieve desired amplitude of waveform, however, SWEEP Vernier Control (28) must be in "CAL" position (fully cw, detent).

NOTE

- To facilitate measurement of one wavelength of displayed signal, adjust SWEEP Control to produce a waveform with a minimum number of cycles.
- At certain signal frequencies, adjustment of SWEEP Control (27) may produce at best, a closely packed waveform containing numerous cycles or multiple (and possible unstable) waveforms not in phase. See examples below:



CLOSELY PACKED WAVEFORM MULTIPLE WAVEFORMS NOT IN PHASE

FIGURE 4-8 EXAMPLES OF CLOSELY PACKED AND MULTIPLE WAVEFORMS

In this situation, operator should select waveform where an accurate measurement of one wavelength (in major graticule divisions) can be made most easily.

9. When a waveform suitable for measurement has been obtained on CRT, use HORIZ Control (36) and VERT Control (38) to align waveform on CRT as follows:

a. Adjust VERT Control (38) to center waveform over any horizontal axis.

b. Adjust HORIZ Control so any "positive going zero crossing" of waveform is aligned with any vertical axis.

STEP PROCEDURE

9. (cont'd)

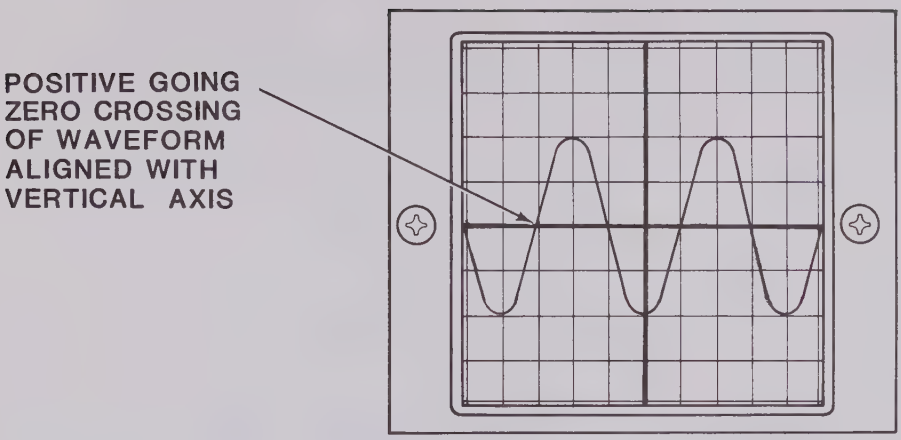
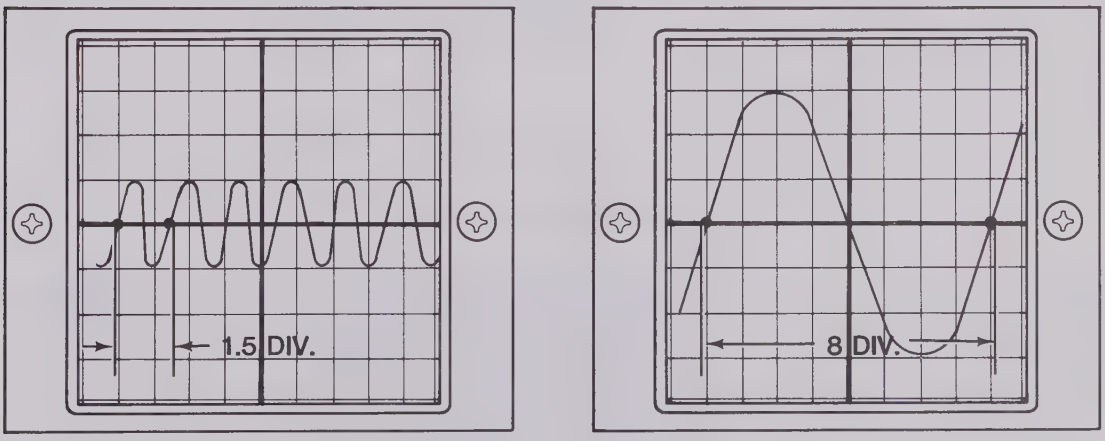


FIGURE 4-9 POSITIVE GOING ZERO POINT OF WAVEFORM ALIGNED WITH VERTICAL AXIS

10. Count number of vertical graticule divisions per one full wavelength, starting at the "positive going zero crossing" aligned in Step 9b. Record this number.

EXAMPLES:



1 WAVELENGTH = 1.5 GRAT. DIV. 1 WAVELENGTH = 8 GRAT. DIV.

FIGURE 4-10 MEASURING WAVELENGTH IN GRATICULE DIVISIONS

11. Apply result obtained in Step 10 to following formula:

$$\frac{1}{\text{No. of graticule divisions}} \times \text{Setting of SWEEP Control} = \text{Approx. frequency of signal under test}$$

STEP	PROCEDURE

11. (cont'd)

EXAMPLE: If the result obtained in Step 10 is 2.5 graticule divisions and setting of SWEEP Control (27) is 0.1 milliseconds, the formula is solved as follows:

$$\frac{1}{(2.5) \times (0.1 \text{ milliseconds})}$$

$$\frac{1}{(2.5) \times (.0001)}$$

$$\frac{1}{.00025} = 4000 \text{ Hz}$$

The result of this equation represents approximate frequency of signal under test.

(For more accurate frequency measurement using "Lissajou" method, perform Steps 12 thru 18.)

12. Place SWEEP Control (27) to "MODULATION FREQ Hz" position. Oscilloscope will now display a solid trace area randomly positioned on CRT.

13. Adjust INT MOD Control (23), EXT V/DIV Control (31) EXT V/DIV Vernier Control (30), HORIZONTAL Control (36) and VERT Control (38) to create a comfortably sized solid square trace area on scope display.

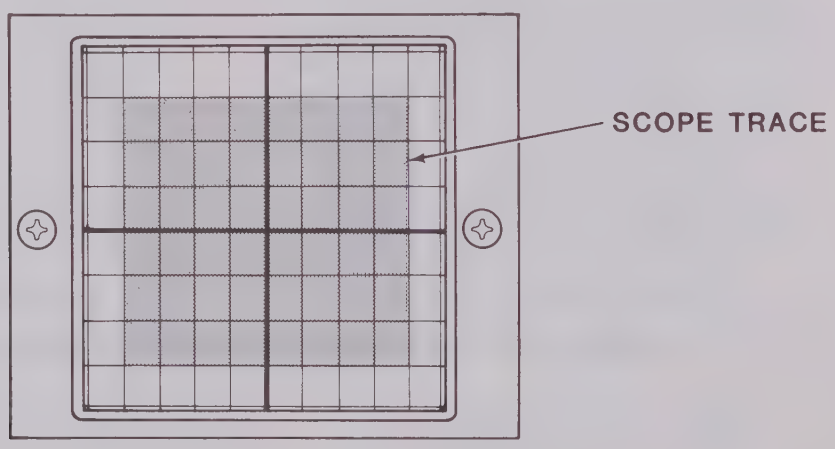


FIGURE 4-11 SOLID SQUARE TRACE AREA DISPLAYED ON CRT

STEP PROCEDURE

14. Set MODULATION FREQ Hz Thumbwheels (25) to signal frequency obtained in Step 11, if that frequency is no greater than 9999.9 Hz.

a. If frequency exceeds 9999.9 Hz, perform following mathematical operation:

If frequency obtained in Step 11 is:	Divide that frequency by:
10 kHz to 19.999 kHz	2
20 kHz to 29.999 kHz	3
30 kHz to 39.999 kHz	4
40 kHz to 49.999 kHz	5

b. Set MODULATION FREQ Hz Thumbwheels (25) to resultant frequency obtained in Step 14a.

15. To determine exact frequency of signal being measured, operator must obtain a stable Lissajou figure on CRT. First determine the order of Lissajou figure being sought by referring to following table:

FREQ. OBTAINED IN STEP 11	LISSAJOU ORDER *
5 Hz to 9999.9 Hz	1 (First)
10 kHz to 19.999 kHz	2 (Second)
20 kHz to 29.999 kHz	3 (Third)
30 kHz to 39.999 kHz	4 (Fourth)
40 kHz to 49.999 kHz	5 (Fifth)

(* See reference chart on page 4-25 for illustration of Lissajou figures.)

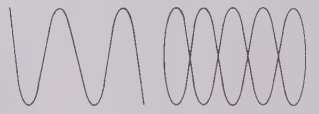
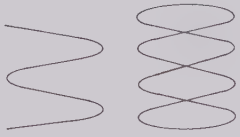
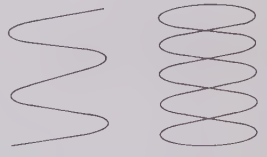
16. Begin incrementing or decrementing MODULATION FREQ Hz Thumbwheels (25) in 10 Hz steps, while carefully observing scope trace for any radical, yet brief oscillation which might be the Lissajou figure being sought. Generally, the exact frequency of the signal under test will be within ±20% of approximate frequency obtained in Step 11.

17. Once the oscillation of scope trace has been detected, continue incrementing or decrementing MODULATION FREQ Hz Thumbwheels (25) in smaller increments until a clear Lissajou figure is visible. Continue until figure is stationary or moving as slowly as possible.

STEP	PROCEDURE

18. Record present setting of MODULATION FREQ Hz Thumbwheels (25). Use table below to determine exact frequency of signal under test:

If frequency obtained in Step 11 was:	Multiply present setting of MODULATION FREQ Hz Thumbwheels (25) by corresponding number below to obtain exact frequency of signal under test:
5 Hz to 9999.9 kHz	1
10 kHz to 19.999 kHz	2
20 kHz to 29.999 kHz	3
30 kHz to 39.999 kHz	4
40 kHz to 49.999 kHz	5

1st ORDER	2nd ORDER	3rd ORDER	4th ORDER	5th ORDER
				
REFERENCE FREQUENCY EQUALS FREQUENCY UNDER TEST	REFERENCE FREQUENCY EQUALS HALF THE FREQUENCY UNDER TEST	REFERENCE FREQUENCY EQUALS ONE THIRD OF THE FREQUENCY UNDER TEST	REFERENCE FREQUENCY EQUALS ONE FOURTH OF FREQUENCY UNDER TEST	REFERENCE FREQUENCY EQUALS ONE FIFTH OF FREQUENCY UNDER TEST
				
REFERENCE FREQUENCY EQUALS FREQUENCY UNDER TEST	REFERENCE FREQUENCY EQUALS TWICE THE FREQUENCY UNDER TEST	REFERENCE FREQUENCY EQUALS THREE TIMES THE FREQUENCY UNDER TEST	REFERENCE FREQUENCY EQUALS FOUR TIMES THE FREQUENCY UNDER TEST	REFERENCE FREQUENCY EQUALS FIVE TIMES THE FREQUENCY UNDER TEST

REFERENCE FREQUENCY = SETTING OF "MODULATION THUMBWHEELS"(25)
FREQUENCY UNDER TEST = SIGNAL APPLIED TO "SCOPE-IN CONNECTOR"(26)

FIGURE 4-12 LISSAJOU FIGURE REFERENCE CHART

4-2-8

TEST PROCEDURE: ***MEASURING PULSE DURATION AND DUTY CYCLE***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for oscilloscope operation as shown in Figure 4-1, page 4-5.
2.	Apply power to FM/AM-1000S/A.
3.	Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately to obtain a sharp visible trace display.

NOTE

- Warm-up time of CRT is approximately 30 seconds from a "cold" start-up; trace display will not become visible until CRT achieves warm-up.

4.	Adjust VERT Control (38) and HORIZ Control (36), to obtain a centered trace aligned along major horizontal axis.
5.	Apply power to UUT.
6.	Apply signal to be measured to a SCOPE IN Connector (26) using a scope probe or coax. If scope probe is used, make sure ground lead is attached to UUT ground.

CAUTION

- DO NOT APPLY MORE THAN 200 VOLTS (PEAK-TO-PEAK) TO SCOPE IN CONNECTOR (26).

7.	Adjust EXT V/DIV Control (31) and EXT V/DIV Vernier Control (30) to obtain a comfortable square wave display.
8.	Adjust SWEEP Control (27) to obtain a minimum number of pulses.

NOTE

- A minimum of two complete pulses must be displayed.

STEP PROCEDURE

9. Adjust HORIZ Control (36) so a "rising edge" of a given pulse is aligned with leftmost vertical axis. Adjust VERT Control (38) so "off-time" of pulse waveform is aligned along major horizontal axis. Display of pulse waveform should now appear as shown:

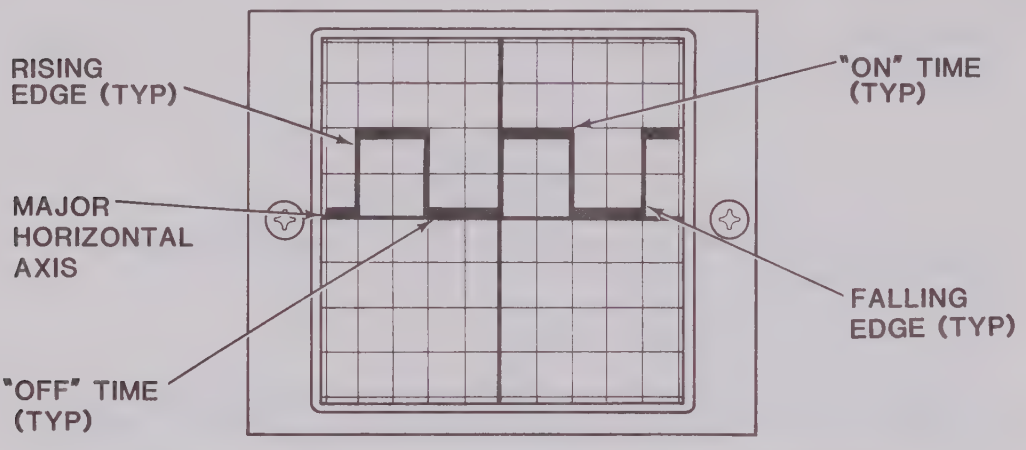


FIGURE 4-13 TYPICAL DISPLAY OF PULSE WAVEFORM

10. Count number of graticule divisions between rising edge of a given pulse and next falling edge; this distance represents time pulse is "ON."

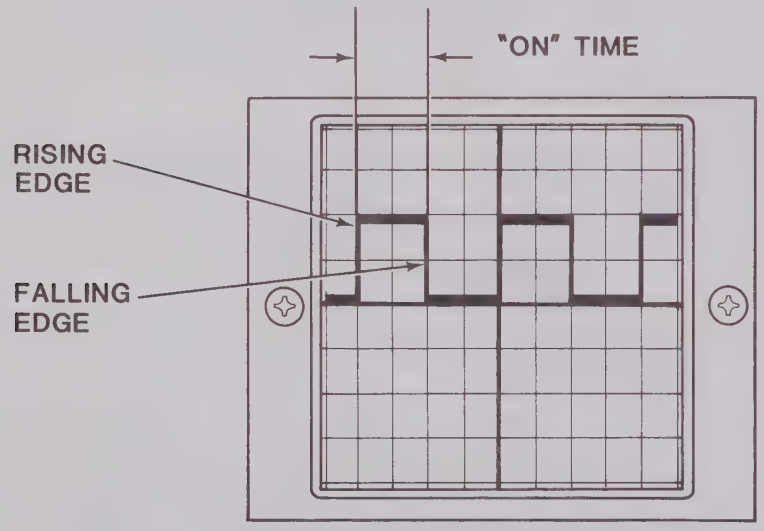


FIGURE 4-14 MEASURING "ON" TIME OF PULSE WAVEFORM

11. Multiply number of graticule divisions representing pulse "ON" time by setting of SWEEP Control (27). Record result.

STEP	PROCEDURE

12. Count number of graticule divisions between rising edge of a given pulse and next rising edge; this distance represents pulse reccurence time (PRT).

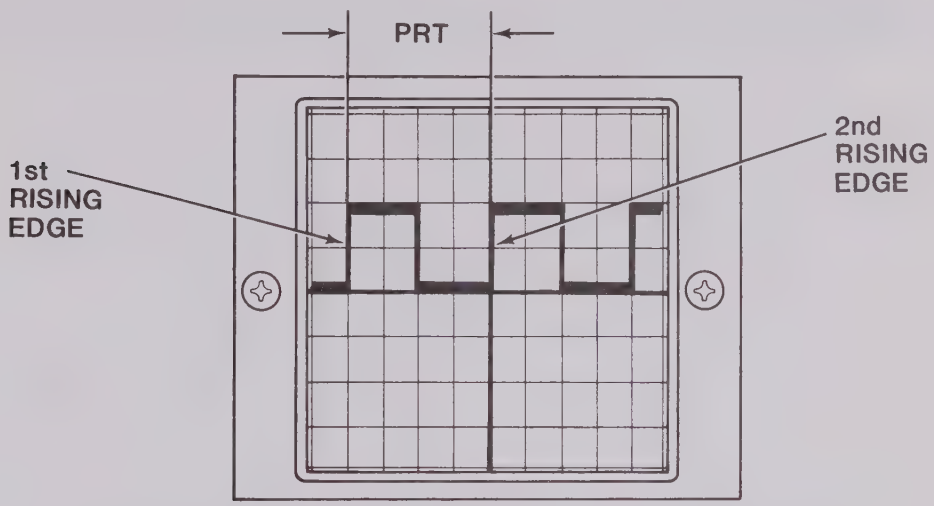


FIGURE 4-15 MEASURING PRT OF PULSE WAVEFORM

13. Multiply number of graticule divisions representing "PRT" by setting of SWEEP Control (27). Record result.

14. To determine duty cycle, apply results from Steps 11 and 13 to following formula:

$$\frac{\text{Result of Step 11}}{\text{Result of Step 13}} \times 100 = \%\ \text{DUTY CYCLE}$$

4-3 TEST PROCEDURES USING FM/AM-1000S SPECTRUM ANALYZER

(THIS SECTION DOES NOT APPLY TO FM/AM-1000A MODELS)

4-3-1 GENERAL

The FM/AM-1000S spectrum analyzer can be used for:

1. Measuring received signal strength and frequency.
2. Displaying the frequency relationship between two or more signals.
3. Displaying the frequency distribution of a signal.
4. Detecting presence of modulation and unwanted or spurious signals.

The dynamic range of the analyzer is 70 dB, covering a range from -30 dBm to -100 dBm.

The test procedures contained in this section are:

4-3-3 MEASURING SIGNAL STRENGTH
4-3-4 DETECTING SPURIOUS SIGNALS

4-3-2 INITIAL FM/AM-1000S CONTROL SETTINGS FOR SPECTRUM ANALYZER OPERATION

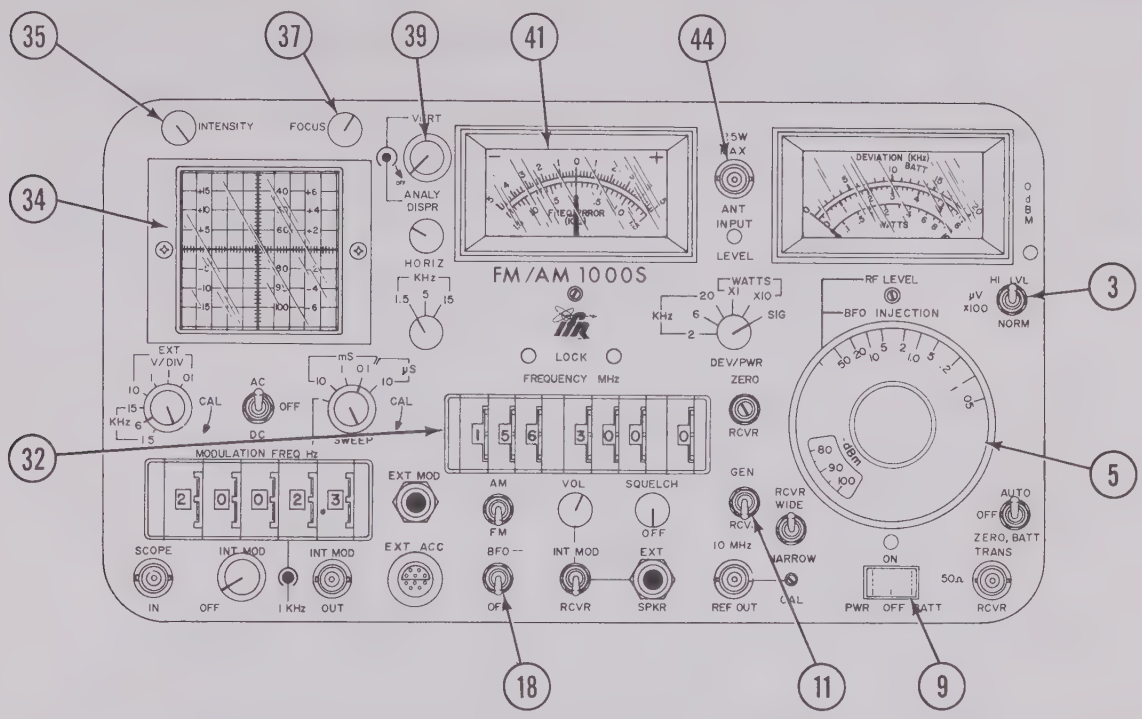


FIGURE 4-16 FM/AM-1000S CONTROLS APPLICABLE TO SPECTRUM ANALYZER OPERATION

(Refer to "SECTION 3 - DESCRIPTION OF CONTROLS, CONNECTORS & INDICATORS" for functional description of any controls used in this section.)

NOTE

- Before performing any procedures contained in this section pertaining to spectrum analyzer operation, make sure all applicable test set controls are positioned as outlined below.
- Some of the control settings outlined below may be changed during the course of a given procedure; all controls, however, should be reset to initial positions described below when starting a new procedure.

	CONTROL	INITIAL SETTING
3	HI LVL/μVx100/NORM Switch	"NORM" position
5	RF LEVEL/BFO INJECTION Dial	Fully ccw
9	PWR/OFF/BATT Switch	"OFF" position
11	GEN/RCVR Switch	"RECEIVER" position
18	BFO/OFF Switch	"OFF" position
35	INTENSITY Control	Midrange position
37	FOCUS Control	Midrange position
39	ANALY DISPR Control	Fully cw

4-3-2 INITIAL FM/AM-1000S CONTROL SETTINGS FOR SPECTRUM ANALYZER OPERATION (CONT'D)

Other FM/AM-1000S features related to spectrum analyzer operation, but not requiring an initial setting:

32 FREQUENCY MHZ Thumbwheels
34 CRT Display
41 FREQ ERROR Meter
44 ANT INPUT Connector

The FM/AM-1000S is now ready for spectrum analyzer operation.

4-3-3

TEST PROCEDURE: ***MEASURING SIGNAL STRENGTH***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set FM/AM-1000S controls for spectrum analyzer operation as shown in Figure 4-16, page 4-33.
2.	Connect external antenna to ANT INPUT Connector (44).

CAUTION

- MAXIMUM CONTINUOUS INPUT TO THIS CONNECTOR MUST NOT EXCEED .25 W.
- MAXIMUM INPUT IS -30 dBm FOR PROPER SPECTRUM ANALYZER OPERATION (signals above -30 dBm may cause spurious signals to be generated and displayed by FM/AM-1000S.)
- IF AN EXTERNAL ANTENNA ATTACHED TO AN UNTERMINATED COAX CABLE IS USED, REMOVE ANY POSSIBLE STATIC CHARGE FROM ANTENNA COAX BEFORE CONNECTION TO FM/AM-1000S.

3.	Apply power to FM/AM-1000S.
4.	Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately to obtain a sharp visible trace display.

NOTE

- Warm-up time of CRT is approximately 30 seconds from a "cold" start-up; trace display will not become visible until CRT achieves warm-up.

STEP	PROCEDURE
5.	Adjust FREQUENCY MHz Thumbwheels (32) so desired signal is aligned along major vertical axis on CRT. Signal to be measured is now on center frequency.

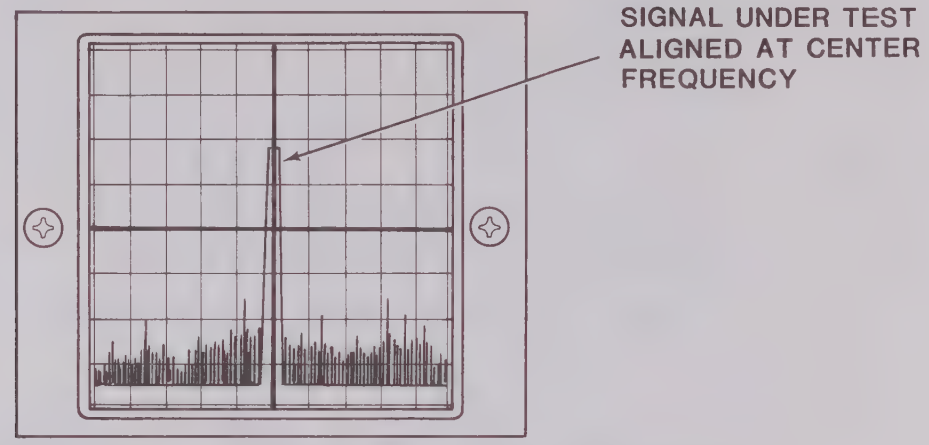


FIGURE 4-17 SIGNAL UNDER TEST DISPLAYED AT CENTER FREQUENCY

6. Rotate ANALY DISPR Control (39) fully ccw, short of detent position.

7. Again adjust FREQUENCY MHz Thumbwheels (32) so desired signal is aligned along major vertical axis on CRT.

8. Measure peak of displayed signal along vertical dB scale. Record measured result.

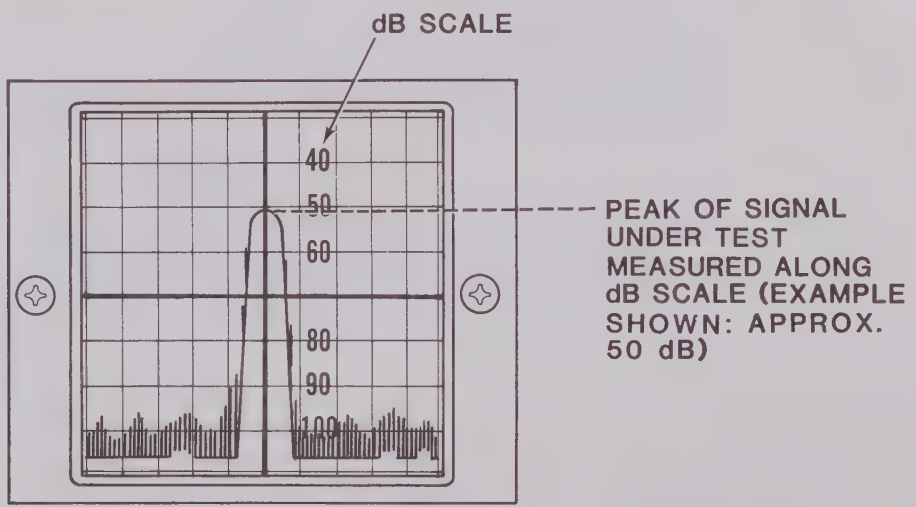


FIGURE 4-18 SIGNAL UNDER TEST MEASURED ALONG dB SCALE OF CRT

STEP PROCEDURE

9. Offset displayed signal to either side of major vertical axis two (2) major graticule divisions by incrementing or decrementing FREQUENCY MHz Thumbwheels (32).

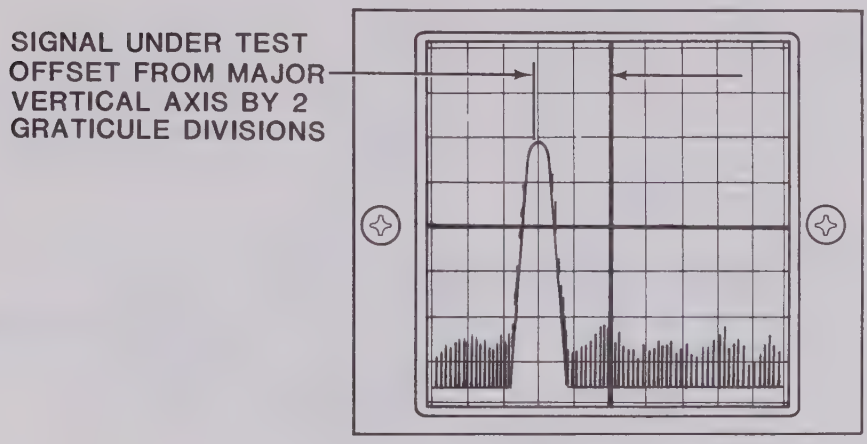


FIGURE 4-19 SIGNAL UNDER TEST OFFSET FROM MAJOR VERTICAL AXIS

10. Place BFO/OFF Switch (18) to "BFO" (ON) position.

11. Rotate RF LEVEL/BFO INJECTION Dial (5) cw so injected BFO signal is the same amplitude as signal under test.

NOTE

- If injected BFO signal cannot be raised to amplitude of signal under test, set HI LVL/µV X 100/ NORM Switch (3) to "µV x 100" position. Again rotate RF LEVEL/BFO INJECTION Dial (5) cw until injected BFO signal matches amplitude of signal under test.

STEP PROCEDURE

5. Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately for a sharp visible trace on CRT.

NOTE

- Warm-up time of CRT is approximately 30 seconds from a "cold" start-up; trace display will not become visible until CRT achieves warm-up.

6. Set FREQUENCY MHz Thumbwheels (32) to desired center frequency.

7. Momentarily shut off and re-apply power to UUT (or in case of a transmitter spectral purity check, key transmitter up and down), while carefully observing carrier signal and surrounding span for any spurious signals.

NOTE

- While interrupting power to UUT (or keying transmitter up and down) certain momentary spikes which protrude above the noise level may appear. Disregard these momentary spikes; look for signals which remain constant in amplitude during this time.

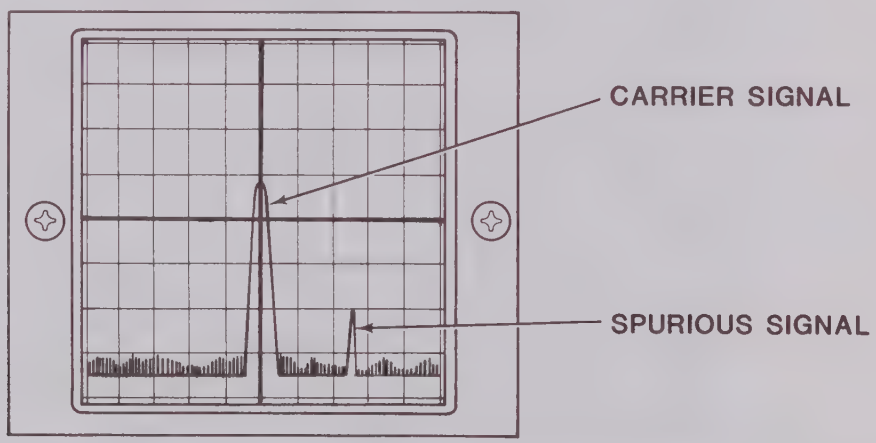


FIGURE 4-21 TYPICAL DISPLAY OF CARRIER SIGNAL AND ADJACENT SPURIOUS SIGNAL

8. To determine origin of spurious signal, increment or decrement 1 MHz and 100 kHz segments of FREQUENCY MHz Thumbwheels (32) several times above or below center frequency.

   a. If the spurious signal moves closer to or further away from carrier signal, spurious signal is being produced by FM/AM-1000S and thus can be disregarded.

STEP	PROCEDURE

8. (cont'd)

b. If spurious signal moves in same direction and same distance as carrier signal, spurious signal is being produced by UUT.

9. To determine frequency of spurious signal.

a. Increment or decrement the FREQUENCY MHz Thumbwheels (32), while rotating ANALY DISPR Control (39) ccw until the spurious signal is aligned with major vertical axis. Present setting of FREQUENCY MHz Thumbwheels (32) represents frequency of spurious signal.

NOTE

- ANALY DISPR Control (39) should be fully ccw, short of detent when final frequency reading is taken.

- To verify actual center of FM/AM-1000S Spectrum Analyzer when in wide dispersion (ANALY DISP Control fully cw), place GEN/RCVR Switch (11) to "GEN"position and observe generated signal:

  (1) If generated signal is aligned with major vertical axis, frequency of detected spurious signal is equal to setting of FREQUENCY MHz Thumbwheels (32).

  (2) If generated signal is not centered over major vertical axis, note position of generated signal on CRT graticule; place GEN/RCVR Switch (11) to "RCVR" position and increment or decrement FREQUENCY MHz Thumbwheels (32) to align spurious signal to same position to which generated signal was previously aligned. Setting of FREQUENCY MHz Thumbwheels (32) now represent frequency of detected spurious signal.

4-4 TEST PROCEDURES USING FM/AM-1000S/A DUAL TONE GENERATOR

4-4-1 GENERAL

The FM/AM-1000S/A contains a dual tone generator capable of generating an approximate 1 kHz fixed audio tone, as well as an audio tone that is variable between 10 Hz and 9999.9 Hz (in 0.1 Hz increments). In addition, an external tone input connector on the FM/AM-1000S/A front panel permits the introduction of a third audio tone from an external signal source. Using this feature, the operator can produce audio frequency signals suitable for:

1. Signaling or testing audio frequency equipment.
2. Amplitude or frequency modulating FM/AM-1000S/A signal generator output.
3. Frequency comparison.

The procedures contained in this section are:

4-4-3 GENERATING AUDIO TONES OF KNOWN AMPLITUDE
4-4-4 USING FM/AM-1000S/A SPEAKER TO ACCOUSTICALLY EXCITE A MICROPHONE

4-4-2 INITIAL FM/AM-1000S/A CONTROL SETTINGS FOR DUAL TONE GENERATOR OPERATION

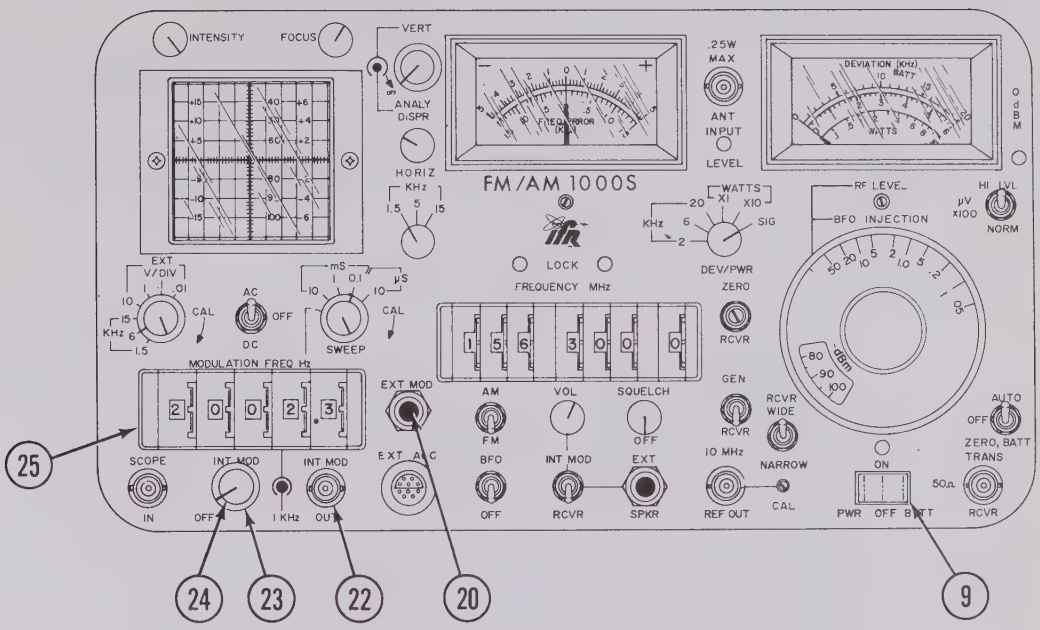


FIGURE 4-22 FM/AM-1000S/A CONTROLS APPLICABLE TO DUAL TONE GENERATOR OPERATION

(Refer to "SECTION 3 - DESCRIPTION OF CONTROLS, CONNECTORS & INDICATORS" for functional description of any controls used in this section.)

NOTE

- Before performing any procedures contained in this section pertaining to dual tone generator operation, make sure all applicable test set controls are positioned as outlined below.
- Some of the control settings outlined below may be changed during the course of a given procedure; all controls, however, should be reset to initial positions described below when starting a new procedure.

	CONTROL	INITIAL SETTING
9	PWR/OFF/BATT Switch	"OFF" position
23	INT MOD Control	Fully ccw, detent (OFF)
24	1 kHz INT MOD Control	Fully ccw, detent (OFF)
25	MODULATION FREQ MHz Thumbwheels	0000.0 Hz

4-4-2 INITIAL FM/AM-1000S/A CONTROL SETTINGS FOR DUAL TONE GENERATOR OPERATION (CONT'D)

Other FM/AM-1000S/A features related to dual tone generator operation, but not requiring an initial setting:

20 EXT MOD Connector
22 INT MOD OUT Connector

The FM/AM-1000S/A is now ready for dual tone generator operation.

TEST PROCEDURE: ***GENERATING AUDIO TONES OF KNOWN AMPLITUDE***

TEST OBJECTIVE: Setting up FM/AM-1000S/A dual tone generator for audio signal injection into UUT.

SPECIAL ACCESSORY EQUIPMENT REQ'D:

1 BNC "tee" connector.

1 short coax cable with male BNC connector on each end.

1 coax cable with male BNC connector on one end and UUT connector on opposite end.

TEST SET-UP DIAGRAM:

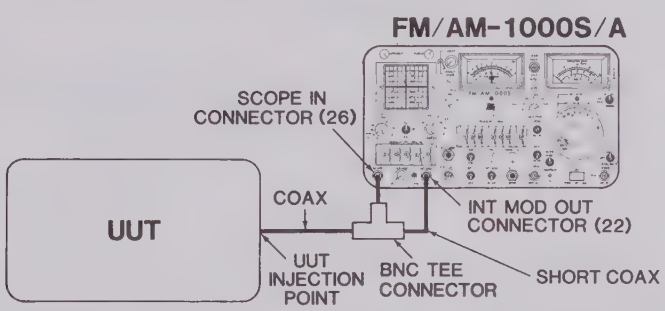


FIGURE 4-23 TEST SET-UP DIAGRAM FOR INJECTING TONE(S) OF KNOWN AMPLITUDE INTO A UUT

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for oscilloscope operation as shown in Figure 4-1, page 4-5.
2.	Set FM/AM-1000S/A controls for dual tone generator operation as shown in Figure 4-22, page 4-45.
3.	Connect BNC "tee" connector to SCOPE IN Connector (26).
4.	Connect one end of short coax cable to INT MOD OUT Connector (22) and opposite end to BNC "tee" connector previously attached to SCOPE IN Connector (26).
5.	Apply power to UUT.
6.	Apply power to FM/AM-1000S/A.
7.	Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately for a sharp visible trace display.

NOTE

- Warm-up time of CRT is approximately 30 seconds from a "cold" start-up; trace display will not become visible until CRT achieves warm-up.

STEP	PROCEDURE
8.	Adjust VERTICAL Control (38) and HORIZONTAL Control (36) so trace is centered and aligned along major horizontal axis.
9.	Set MODULATION FREQUENCY Hz Thumbwheels (25) to desired audio frequency.
10.	Connect BNC connector of remaining coax cable to "tee" connector attached to SCOPE IN Connector (26). Connect opposite end of coax cable to injection point on UUT.
11.	For calibration, injected audio tone must be expressed in volts peak. Signals expressed in volts RMS or volts peak-to-peak must therefore be converted to volts peak, using following formulas.

$$\text{VOLTS PEAK} = (1.414) \times (\text{VOLTS RMS})$$

$$\text{VOLTS PEAK} = \frac{\text{Volts peak-to-peak}}{2}$$

NOTE

- If desired audio level is below 4 volts peak, place EXT V/DIV Control to 1 V/DIV setting.

12. Rotate INT MOD Control (23) to adjust waveform display to desired amplitude in volts peak. Desired audio tone is now being injected into UUT.

EXAMPLE:

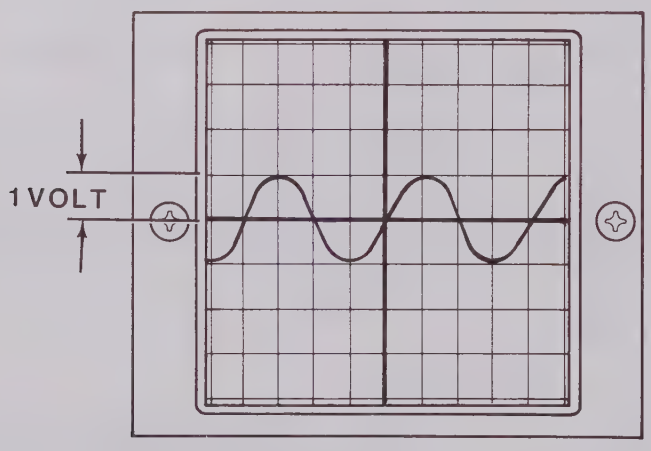


FIGURE 4-24 AMPLITUDE OF DISPLAYED WAVEFORM ADJUSTED 1 VOLT PEAK

13. To monitor the injected tones, place INT MOD/RCVR Switch (16) to "INT MOD" position and adjust VOL Control (17) to a comfortable listening level.

TEST PROCEDURE: ***USING FM/AM-1000S/A SPEAKER TO ACCOUSTICALLY EXCITE A MICROPHONE***

TEST OBJECTIVE: Exciting an external microphone with a sine wave of a known frequency.

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for dual tone generator operation as shown in Figure 4-22, page 4-45.
2.	Set MODULATION FREQ Hz Thumbwheels (25) for desired audio modulation tone.
3.	Place INT MOD/RCVR Switch (16) to "INT MOD" position.
4.	Rotate INT MOD Control (23) to a midrange position.
5.	Apply power to FM/AM-1000S/A.
6.	Adjust VOL Control (17) to a comfortable listening level.
7.	Apply power to UUT.
8.	Key UUT microphone while holding microphone next to FM/AM-1000S/A internal speaker (located on right side of FM/AM-1000S/A). Use FM/AM-1000S/A monitoring features to analyze UUT modulation capabilities.

4-5 TEST PROCEDURES USING FM/AM-1000S/A RF GENERATOR

4-5-1 GENERAL

The FM/AM-1000S/A signal generator is capable of generating calibrated amplitude signals from 100 Hz to 999.999 MHz (in 100 Hz increments).

NOTE

- When HI LVL/µV X 100/NORM Switch (3) is positioned to "HI LVL", RF output range is 50 kHz to 999.999 MHz.

The generator function can be used to stimulate external devices by generating unmodulated RF signals, AM modulated RF signals and FM modulated RF signals. The generator output may also be swept over a short frequency span for bandwidth testing of external devices.

The procedures contained in this section are:

4-5-3 GENERATING RF SIGNALS
4-5-4 GENERATING AM MODULATED RF SIGNALS
4-5-5 GENERATING FM MODULATED RF SIGNALS

4-5-2 FM/AM-1000S/A CONTROL SETTINGS FOR RF GENERATOR OPERATION

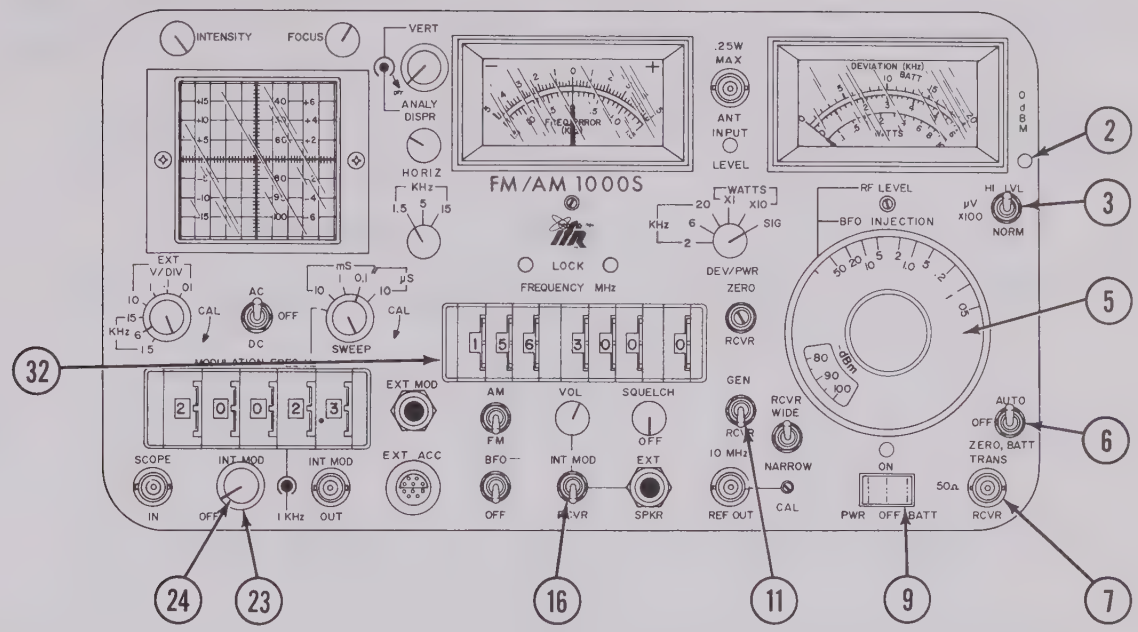


FIGURE 4-25 FM/AM-1000S/A CONTROLS APPLICABLE TO RF GENERATOR OPERATION

(Refer to "SECTION 3 - DESCRIPTION OF CONTROLS, CONNECTORS & INDICATORS" for functional description of any controls used in this section.)

NOTE

- Before performing any procedures contained in this section pertaining to RF generator operation, make sure all applicable test set controls are positioned as outlined below.
- Some of the control settings outlined below may be changed during the course of a given procedure; all controls, however, should be reset to initial positions described below when starting a new procedure.

	CONTROL	INITIAL SETTING
3	HI LVL/µV X 100/NORM Switch	"NORM" position
5	RF LEVEL/BFO INJECTION Dial	Fully ccw
6	AUTO/OFF/ZERO, BATT Switch	"AUTO" position
9	PWR/OFF/BATT Switch	"OFF" position
10	RCVR WIDE/MID/NARROW Switch	"NARROW" position
11	GEN/RCVR Switch	"GEN" position
16	INT MOD/RCVR Switch	"RCVR" position
23	INT MOD Control	Fully ccw, detent (OFF)
24	1 kHz INT MOD Control	Fully ccw, detent (OFF)

4-5-2 INITIAL FM/AM-1000S/A CONTROL SETTINGS FOR RF GENERATOR OPERATION

Other FM/AM-1000S/A features related to RF generator operation, but not requiring an initial setting:

2 0 dBm Lamp
7 TRANS/RCVR Connector
32 FREQUENCY MHz Thumbwheels

The FM/AM-1000S/A is now ready for RF generator operation.

4-5-3

TEST PROCEDURE: ***GENERATING RF SIGNALS***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for RF generator operation as shown in Figure 4-25, page 4-53.
2.	Apply power to FM/AM-1000S/A.
3.	Set FREQUENCY MHz Thumbwheels (32) to desired RF frequency output.
4.	For an RF output less than 50 µV, rotate RF LEVEL/BFO INJECTION Dial (5) to desired "µV" setting.

NOTE

- RF output in dBm can be determined by reading setting of RF LEVEL/BFO INJECTION Dial (5) on dBm scale.

The FM/AM-1000S/A is now generating RF signals at desired frequency and output level.

5. For an RF output level greater than 50 µV (but less than 5000 µV):

   a. Place HI LEVEL/µV X 100/NORM Switch (3) to "µV x 100" position.

   b. Rotate RF LEVEL/BFO INJECTION Dial (5) to desired "µV" setting. The FM/AM-1000S/A is now generating RF signals at desired frequency and output level.

NOTE

- RF output level in "µV" is now 100 times the setting of RF LEVEL/BFO INJECTION Dial (5) on "µV" scale.

STEP PROCEDURE

5. (cont'd)

NOTE

- Equivalent RF output level in dBm can be determined by mathematically adding +40 dBm to reading of RF LEVEL/BFO INJECTION Dial (5) on dBm scale.

  EXAMPLE: RF output level as indicated on dial: -100 dBm

  -100 dBm + (+40 dBm) =
  -100 dBm + 40 dBm = -60 dBm output

6. For an RF output level greater than -35 dBm:

   a. Rotate RF LEVEL/BFO INJECTION Dial (5) fully ccw.

   b. Place HI LVL/μV X 100/NORM Switch (3) to "HI LVL" position.

   c. Slowly rotate RF LEVEL/BFO INJECTION Dial (5) cw until 0 dBm Lamp (2) illuminates.

   d. Record setting of RF LEVEL/BFO INJECTION Dial (5) on dBm scale.

   e. Add result obtained in Step 6d to desired RF output level in dBm. Record result.

   f. Rotate RF LEVEL/BFO INJECTION Dial (5) to setting obtained in Step 6e.

   g. The FM/AM-1000S/A is now generating RF signals at desired frequency and output level.

   EXAMPLE:

   (1) Desired RF output level: -25 dBm

   (2) RF LEVEL/BFO INJECTION Dial (5) setting when 0 dBm Lamp (2) illuminates: -75 dBm

   (3) Add (1) to (2): (-25) + (-75) = -100 dBm

   (4) Rotate RF LEVEL/BFO INJECTION Dial (5) to -100 dBm; RF output level of FM/AM-1000S/A is now -25 dBm.

TEST PROCEDURE: ***GENERATING AM MODULATED RF SIGNALS***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Perform procedure 4-5-3, titled "GENERATING RF SIGNALS", on page 4-55.
2.	Place AM/FM Switch (19) to "AM."
3.	Set "MODULATION FREQ Hz Thumbwheels (25) to desired tone modulation frequency.
4.	On FM/AM-1000S models, make sure ANALY DISPR Control (39) is fully ccw to detent position.
5.	Place EXT V/DIV Control (31) to "1.5 kHz", "6 kHz" or "15 kHz" position.
6.	Rotate EXT V/DIV Vernier Control (30) to "CAL" position.
7.	Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately for a sharp visible trace display.
8.	Adjust VERT Control (38) and HORIZ Control (36) to obtain a centered trace, with lower edge of displayed carrier aligned with major horizontal axis.

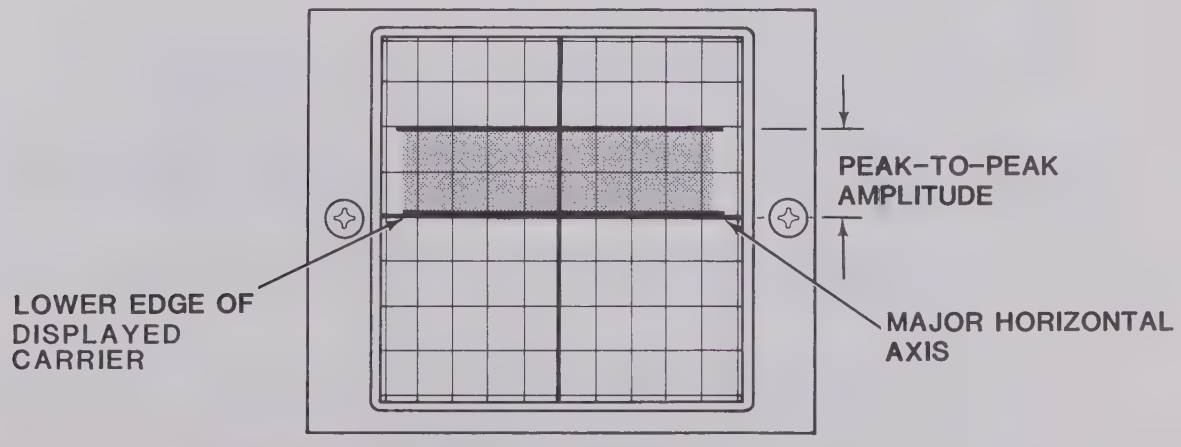


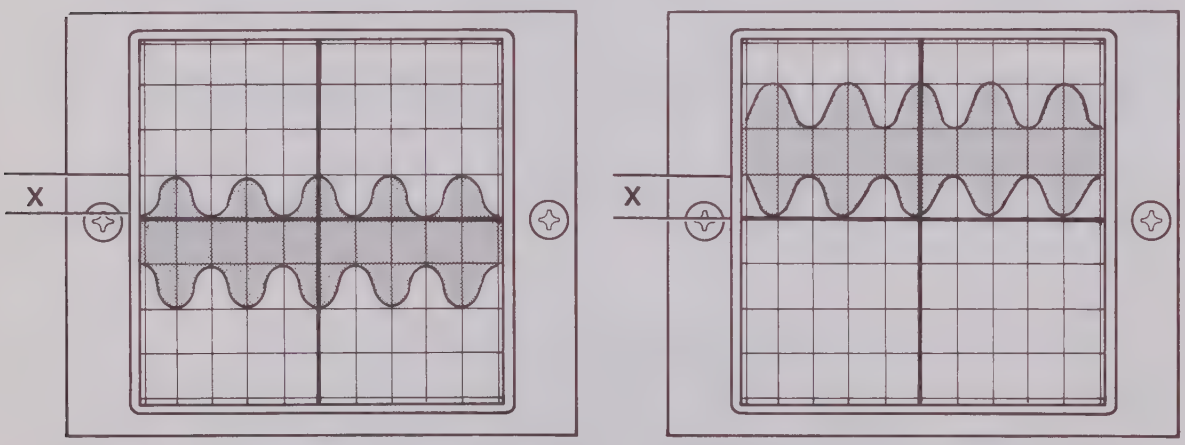
FIGURE 4-26 DISPLAYED CARRIER ALIGNED WITH LOWER EDGE RESTING ON MAJOR HORIZONTAL AXIS

STEP	PROCEDURE
9.	Measure peak-to-peak amplitude (in graticule divisions) of displayed carrier. Record result.
10.	Apply result obtained in Step 9 to the following equation: $x = \frac{(\text{desired \% modulation}) \times (\text{result of Step 9})}{100}$ where x = number of graticule divisions (peak-to-peak) of modulated signal.
11.	a. Adjust VERTICAL Control (38) to align negative peak of one of the modulated signals with the major horizontal axis.
	b. Rotate INT MOD Control (23) to adjust peak-to-peak amplitude of the same modulated signal (in graticule divisions) to the value of "x" obtained in Step 10.

NOTE

- Steps 11a and 11b must be performed simultaneously, as both are interactive.

EXAMPLES:



DISPLAYED WAVEFORM WITH UPPER MODULATED SIGNAL ALIGNED ALONG MAJOR HORIZONTAL AXIS

DISPLAYED WAVEFORM WITH LOWER MODULATED SIGNAL ALIGNED ALONG MAJOR HORIZONTAL AXIS

FIGURE 4-27 ALIGNMENT OF UPPER & LOWER MODULATION SIGNALS WITH MAJOR HORIZONTAL AXIS

c. The FM/AM-1000S/A signal generator is now calibrated to desired percent modulation and is generating at selected frequency and output level.

TEST PROCEDURE: ***GENERATING FM MODULATED RF SIGNALS***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Perform procedure 4-5-3, titled "GENERATING RF SIGNALS", on page 4-55.
2.	Place AM/FM Switch (19) to "FM."
3.	Set MODULATION FREQ Hz Thumbwheels (25) to desired tone modulation frequency.
4.	Place DEV/PWR Control (47) to desired deviation range (2, 6 or 20 kHz).
5.	Rotate INT MOD Control (23) cw while observing DEVIATION/WATTS Meter (1) until meter indicates desired deviation on appropriate scale.

NOTE

- If deviation is above 5 kHz, place RCVR WIDE/MID/NARROW Switch (10) to "MID" or "WIDE" position.
- Signals at a 1 kHz rate with more than ±5 kHz deviation must be monitored with RCVR WIDE/MID/NARROW Switch (10) in "MID" position.
- Signals modulated above 2 kHz should be monitored with RCVR WIDE/MID/NARROW Switch (10) in "WIDE" position. Note residual modulation indication due to noise on DEVIATION/WATTS Meter (1); add this value to desired value. Total represents indicated deviation value on DEVIATION/WATTS Meter (1).

The FM/AM-1000S/A is now generating FM modulated RF signals within desired deviation range.

4-6 TEST PROCEDURES USING FM/AM-1000S/A RECEIVER

4-6-1 GENERAL

The FM/AM-1000S/A contains a sensitive AM/FM communications receiver capable of receiving signals within a range of 300 kHz to 999.999 MHz (in 100 Hz increments). The receiver function enables the operator to measure the characteristics of most radiated signals, including CW and SSB.

The procedures contained in this section are:

4-6-3 RECEIVING AM OR FM SIGNALS
4-6-4 RECEIVING SIDEBAND SIGNALS
4-6-5 RECEIVING CW SIGNALS
4-6-6 RECEIVING TIME STANDARD SIGNAL TO CALIBRATE FM/AM-1000S/A MASTER OSCILLATOR.
4-6-7 CALIBRATING FM/AM-1000S/A MASTER OSCILLATOR THROUGH AN EXTERNAL FREQUENCY STANDARD.

4-6-2 INITIAL FM/AM-1000S/A CONTROL SETTINGS FOR RECEIVER OPERATION

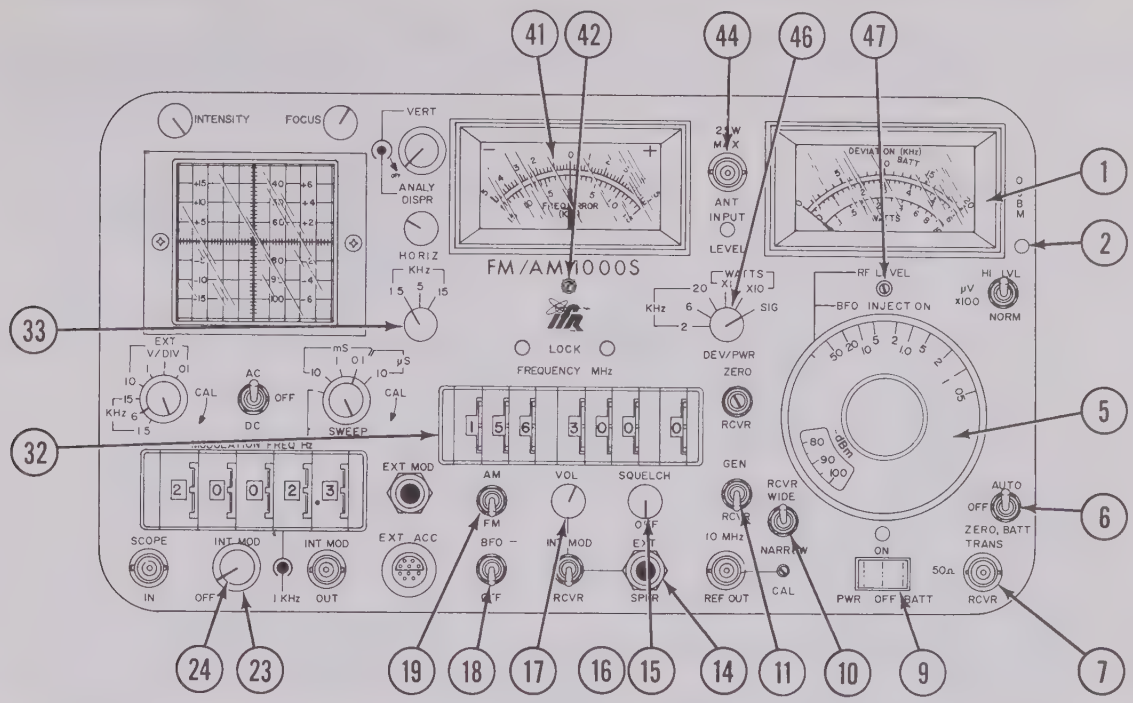


FIGURE 4-28 FM/AM-1000S/A CONTROLS APPLICABLE TO RECEIVER OPERATION

(Refer to "SECTION 3 - DESCRIPTION OF CONTROLS, CONNECTORS & INDICATORS" for functional description of any controls used in this section.)

NOTE

- Before performing any procedures contained in this section pertaining to receiver operation, make sure all applicable test set controls are positioned as outlined below.
- Some of the control settings outlined below may be changed during the course of a given procedure; all controls, however, should be reset to initial positions described below when starting a new procedure.

	CONTROL	INITIAL SETTING
5	RF LEVEL/BFO INJECTION Dial	Fully ccw
6	AUTO/ZERO/OFF/ZERO, Batt Switch	"AUTO" position
9	POWER/OFF/BATT Switch	"OFF" position
10	RCVR WIDE/MID/NARROW Switch	"WIDE" position
11	GEN/RCVR Switch	"RECEIVER" position
15	SQUELCH Control	Fully ccw, short of detent
16	INT MOD/RCVR Switch	"RECEIVER" position
17	VOL Control	Fully ccw
18	BFO/OFF Switch	"OFF" position

4-6-2 INITIAL FM/AM-1000S/A CONTROL SETTINGS FOR RECEIVER OPERATION (CONT'D)

	CONTROL	INITIAL SETTING
19	AM/FM Switch	"AM" or "FM" position depending on mode of signal to be received.
23	INT MOD Control	Fully ccw, detent (OFF)
24	1 kHz INT MOD Control	Fully ccw, detent (OFF)
33	1.5/5/15 kHz Control	"15 kHz" position
47	DEV/PWR Control	"SIG" position

Other FM/AM-1000S/A features related to receiver operation, but not requiring an initial setting:

1	DEVIATION/WATTS Meter
2	0 dBm Lamp
4	ZERO RCVR Adjustment
7	TRANS/RCVR Connector
14	EXT SPKR Connector
32	FREQUENCY MHz Thumbwheels
41	FREQ ERROR Meter
42	FREQ ERROR Meter Zero Adjustment
44	ANT INTPUT Connector
47	DEVIATION/WATTS Meter Zero Adjustment

The FM/AM-1000S/A is now ready for receiver operation.

4-6-3

TEST PROCEDURE: ***RECEIVING AM OR FM SIGNALS***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for receiver operation as shown in Figure 4-28, page 4-63.
2.	Place AM/FM Switch (19) to desired signal mode position.
3.	Select desired method for signal reception:

a. External Antenna
Connect external antenna to ANT INPUT Connector (44) for "off-the-air" monitoring.

CAUTION

- MAXIMUM CONTINUOUS INPUT TO THIS CONNECTOR MUST NOT EXCEED .25 W.
- ON FM/AM-1000S MODELS, MAXIMUM INPUT IS -30 dBM FOR PROPER SPECTRUM ANALYZER OPERATION (SIGNALS ABOVE -30 dBm MAY CAUSE SPURIOUS SIGNALS TO BE GENERATED AND DISPLAYED BY FM/AM-1000S SPECTRUM ANALYZER).
- IF AN EXTERNAL ANTENNA ATTACHED TO AN UNTERMINATED COAX CABLE IS USED, REMOVE ANY POSSIBLE STATIC CHARGE FROM ANTENNA COAX BEFORE CONNECTING TO FM/AM-1000S/A.

b. Direct Cable Connection from UUT
Connect cable from UUT to TRANS/RCVR Connector (7).

CAUTION

- DO NOT APPLY MORE THAN 20 WATTS OF CONTINUOUS INPUT TO TRANS/RCVR CONNECTOR (7).
- Maximum "ON" time for measurement of transmitter output using TRANS/RCVR Connector (7) is:

10 seconds at 100 W, 15% Duty Cycle
20 seconds at 50 W, 30% Duty Cycle
2 minutes at 30 W, 50% Duty Cycle

STEP	PROCEDURE
4.	Apply power to FM/AM-1000S/A.
5.	Apply power to UUT (if applicable).
6.	Set FREQUENCY MHz Thumbwheels (32) to frequency of signal to be received.
7.	Adjust VOL Control (17) to a comfortable listening level.
8.	If an area of the spectrum is being monitored where frequency channels are packed closely together, bandwidth of signal may be reduced by placing RCVR WIDE/MID/NARROW Switch (10) to "MID" or "NARROW" setting.

NOTE

- "NARROW" setting of RCVR WIDE/MID/NARROW Switch (10) will not accommodate greater than ±5 kHz FM deviation of most FM transmitters, when monitoring FM signals. If FM deviation is more than ±5 kHz, place RCVR WIDE/MID/NARROW Switch to "MID" position.

9. Fine tuning of FM/AM-1000S/A receiver to center frequency (within ±100 Hz) is accomplished as follows:

   a. If FREQ ERROR Meter (41) appears centered at zero, proceed to Step 9b; if meter needle is not centered, increment or decrement FREQUENCY MHz Thumbwheels (32) in 10 kHz and 1 kHz steps to center needle as closely as possible to zero, then proceed to Step 9b.

   b. Rotate 1.5/5/15 kHz Control (33) to "5 kHz" position. If FREQ ERROR Meter (41) remains centered at zero, proceed to Step 9c; if meter needle deviates from zero, increment or decrement FREQUENCY MHz Thumbwheels (32) in 1 kHz steps to center needle as closely as possible to zero, then proceed to Step 9c.

   c. Rotate 1.5/5/15 kHz Control (33) to "1.5 kHz" position. Increment or decrement FREQUENCY MHz Thumbwheels (32) in 100 Hz steps until meter needle is centered at zero (within ±1 minor division on meter scale). Setting of FREQUENCY MHz Thumbwheels (32) now reflects exact frequency of received signal.

10. Place SQUELCH Control (15) fully ccw, short of detent or as required.

STEP	PROCEDURE
11.	If received signal is being monitored through a direct cable connection at TRANS/RCVR Connector (7), rotate DEV/PWR Control (47) to "Watts x 10" position. If DEVIATION/WATTS Meter (1) reading is under 10 watts (on red scale), rotate DEV/PWR Control (47) to "Watts x 1" position.
12.	Output power of UUT can now be measured on red scale of DEVIATION/WATTS Meter (1).

NOTE

- For signals received "off-the-air", a qualitative representation of relative signal strength can be determined by observing DEVIATION/WATTS Meter (1) needle deflection (with DEV/PWR Control Control (47) in "SIG" position). As signal strength increases, the meter needle deflection will increase towards right of meter scale. For exact measurement of "off-the-air" signal strength on FM/AM-1000S models, refer to procedure 4-3-3, titled "MEASURING SIGNAL STRENGTH" on page 4-35.

TEST PROCEDURE: ***RECEIVING SIDEBAND SIGNALS***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Perform procedure 4-6-3, titled "RECEIVING AM or FM SIGNALS" on page 4-65.
2.	Place BFO/OFF Switch (18) to "BFO" (ON) position.
3.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw until sideband becomes understandable.
4.	Increment or decrement FREQUENCY MHz Thumbwheels (32) in 100 Hz steps as necessary to "clarify" signal.

NOTE

- Excessive BFO quiets the receiver and depresses audio output, while insufficient BFO causes distortion.

TEST PROCEDURE: ***RECEIVING CW SIGNALS***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Perform all steps of procedure 4-6-3, titled "RECEIVING AM or FM SIGNALS" on page 4-65, with exception of Step 7, which is to be disregarded.
2.	Place BFO/OFF Switch (18) to "BFO" (ON) position.
3.	Place AM/FM Switch (19) to "AM" position.
4.	Increment or decrement FREQUENCY MHz Thumbwheels (32) 1 kHz or as desired.
5.	Rotate RF LEVEL/BFO INJECTION Dial (5) and VOL Control (17) cw simultaneously until beat frequency becomes audible.

4-6-6

TEST PROCEDURE: ***RECEIVING TIME STANDARD SIGNAL TO CALIBRATE FM/AM-1000S/A MASTER OSCILLATOR***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: 1 small flatblade screwdriver

1 short length of wire (18 ga.)

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Perform procedure 4-6-3, titled "RECEIVING AM OR FM SIGNALS" on page 4-65.

NOTE

- AM/FM Switch (19) should be in "AM" position.
- Frequency to be received is 10.000 MHz (WWV Time Standard Radio Station.)
- DEV/PWR Control (47) should be in "SIG" position.

2. Set FM/AM-1000S/A controls for oscilloscope operation as shown in Figure 4-1, page 4-5.

3. Rotate EXT V/DIV Switch (31) to "15 kHz" position.

4. Insert a short length of wire into center conductor of 10 MHz REF OUT Connector (13).

5. Adjust position of wire to obtain a suitable beat note from FM/AM-1000S/A speaker.

6. Using small screwdriver, rotate 10 MHz CAL Adjustment (12) appropriately until beat note achieves as low a frequency as possible:

   a. Initially, it will be helpful to observe oscillation of waveform on oscilloscope while rotating 10 MHz CAL Adjustment (12); rotate screw until oscillation diminishes to a point of being as close as possible to stationary.

STEP	PROCEDURE

6. (cont'd)

   b. Continue adjustment of 10 MHz CAL Adjustment (12) while observing DEVIATION/WATTS Meter (1) until meter needle oscillation becomes as slow as possible. During this step, recheck oscilloscope display to make sure waveform remains stable. Master oscillator of FM/AM-1000S/A is now calibrated in accordance with WWV.

NOTE

- Careful calibration can result in a beat frequency less than 0.1 Hz.
- The needle indication described in Step 6b may not occur if the WWV transmitter is in close proximity to the FM/AM-1000S/A.

7. In addition to calibrating the FM/AM-1000S/A master oscillator for accurate frequency reference/measurement, the FM/AM-1000S/A FREQ ERROR Meter (41) should also be zeroed for reliable frequency measurements. Procedure is as follows:

   a. Place GEN/RCVR Switch (11) to "GEN" position.

NOTE

- RCVR WIDE/MID/NARROW Switch (10) must be in "NARROW" position.

   b. Make sure AUTO/OFF/ZERO, BATT Switch (6) is in "AUTO" position.

   c. Rotate 1.5/5/15 kHz Control (33) to "1.5 kHz" position.

   d. Adjust ZERO RCVR Adjustment (4) cw or ccw to center FREQ ERROR Meter (41) needle at zero.

4-6-7

TEST PROCEDURE: ***CALIBRATING FM/AM-1000S/A MASTER OSCILLATOR THROUGH AN EXTERNAL FREQUENCY STANDARD***

TEST OBJECTIVE: Alternate procedure for calibrating FM/AM-1000S/A master oscillator through an external source (e.g. frequency counter) when a 10 MHz "off-the-air" reference signal is not available.

SPECIAL ACCESSORY EQUIPMENT REQ'D: 1 Coax cable with male BNC connector on each end

1 Frequency Counter

TEST SET-UP DIAGRAM:

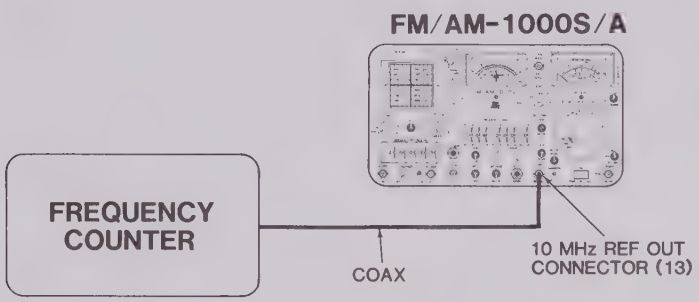


FIGURE 4-29 TEST SET-UP DIAGRAM FOR CALIBRATING FM/AM-1000S/A MASTER OSCILLATOR

STEP	PROCEDURE
1.	Connect one end of coax cable to 10 MHz REFERENCE OUT Connector (13).
2.	Connect opposite end of coax cable to input of frequency counter.
3.	Apply power to frequency counter.
4.	Apply power to FM/AM-1000S/A.
5.	For most precise adjustment, wait approximately 5 minutes before proceeding with Step 6.
6.	Adjust 10 MHz CAL Adjustment (12) until frequency counter reads 10 MHz, ±1 Hz. FM/AM-1000S/A master oscillator is now calibrated to frequency counter.

STEP	PROCEDURE
7.	In addition to calibrating the FM/AM-1000S/A master oscillator for accurate frequency reference/measurement, the FM/AM-1000S/A FREQ ERROR Meter (41) should also be zeroed for reliable frequency measurements. Procedure is as follows:

a. Place GEN/RCVR Switch (11) to "GEN" position.

NOTE

- RCVR WIDE/MID/NARROW Switch (10) must be in "NARROW" position.

b. Make sure AUTO/OFF/ZERO, BATT Switch (6) is in "AUTO" position.

c. Rotate 1.5/5/15 kHz Control (33) to "1.5 kHz" position.

d. Adjust ZERO RCVR Adjustment (4) cw or ccw to center FREQ ERROR Meter (41) needle at zero.

4-7 TEST PROCEDURES USING FM/AM-1000S/A AS A SWEEP GENERATOR /TRACKING OSCILLOSCOPE

4-7-1 GENERAL

The RF output of the FM/AM-1000S/A signal generator can be caused to sweep by as much as ±20 kHz. Since the horizontal scan of the FM/AM-1000S/A is synchronized to the dual tone generator output, the FM/AM-1000S/A oscilloscope can be used to track the swept RF signal output. This permits direct viewing of filter, crystal and tuned circuit response curves on the FM/AM-1000S/A oscilloscope.

IMPORTANT CONSIDERATIONS APPLICABLE TO PROCEDURES CONTAINED IN THIS SECTION:

- When using FM/AM-1000S/A as a Sweep Generator/Tracking Oscilloscope, frequency display on CRT is inverted; i.e. frequency is maximum on left side of CRT and minimum on right side of CRT.
- Certain circuits exhibiting severe attenuation may not provide sufficient detector output to obtain necessary scope deflection.
- A circuit under test must be highly selective to show a response curve within the 40 kHz displayed span.
- High impedance (Hi-Z) circuits should be monitored using a detector probe.
- When testing knotch, highpass and lowpass circuits, best results are normally obtained at or near 0 dBm output. If smaller levels are required, use maximum output with HI LVL/µV X 100/NORM Switch (3) in "µV X 100" position.
- DC blocking capacitors are required only for active circuits.
- If circuit under test (CUT) is an amplifier, make sure amplifier:

  (1) is terminated with proper load impedance.
  (2) power out does not exceed detector parameters.
  (3) is not saturated.

The test procedures contained in this section are:

4-7-3 USING FM/AM-1000S/A AS A SWEEP GENERATOR/ TRACKING OSCILLOSCOPE
4-7-4 MEASURING BANDPASS AND CENTER FREQUENCY OF A BANDPASS CIRCUIT
4-7-5 MEASURING BANDREJECT AND CENTER FREQUENCY OF KNOTCH CIRCUITS
4-7-6 MEASURING CUT-OFF FREQUENCY OF LOWPASS CIRCUITS
4-7-7 MEASURING CUT-OFF FREQUENCY OF HIGHPASS CIRCUITS

4-7-2 INITIAL FM/AM-1000S/A CONTROL SETTING FOR SWEEP GENERATOR/TRACKING OSCILLOSCOPE OPERATION

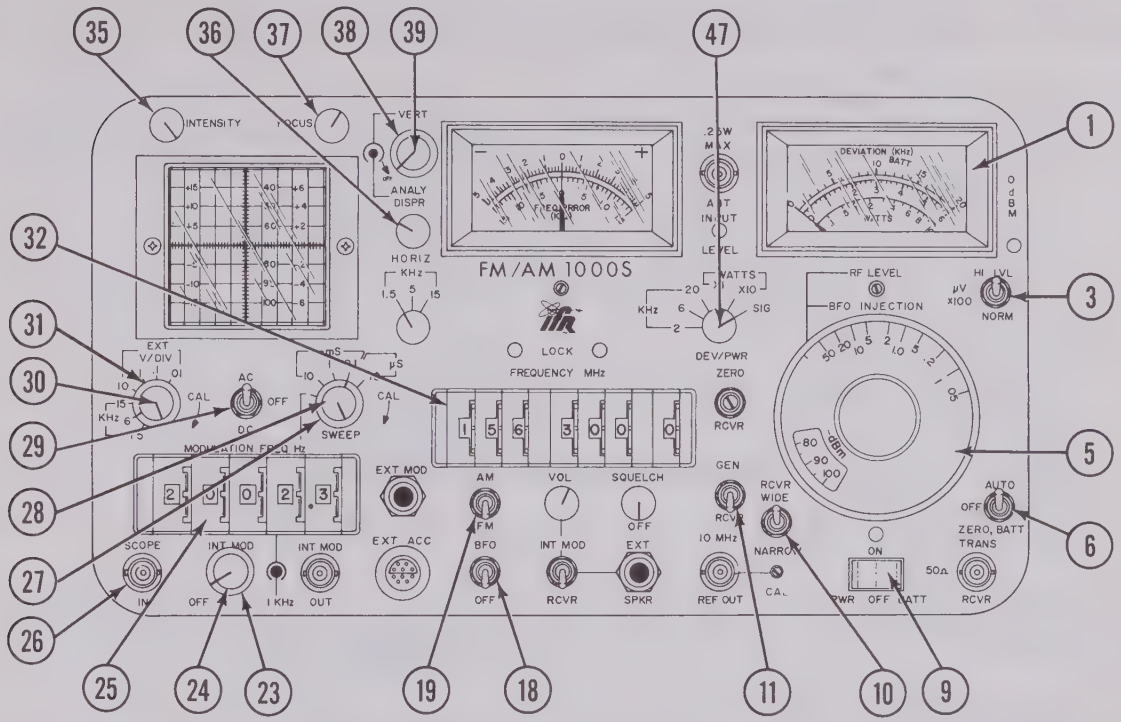


FIGURE 4-30 FM/AM-1000S/A CONTROLS APPLICABLE TO SWEEP GENERATOR/ TRACKING OSCILLOSCOPE OPERATION

(Refer to "SECTION 3 - DESCRIPTION OF CONTROLS, CONNECTORS & INDICATORS" for functional description of any controls used in this section.)

NOTE

- Before performing any procedures contained in this section pertaining to sweep generator/tracking oscilloscope operation, make sure all applicable test set controls are positioned as outlined below.
- Some of the control settings outlined below may be changed during the course of a given procedure; all controls, however, should be reset to initial positions described below when starting a new procedure.

	CONTROL	INITIAL SETTING
3	HI LVL/μV X 100/NORM Switch	"HI LVL" position
5	RF LEVEL/BFO INJECTION Dial	Fully ccw
6	AUTO/OFF/ZERO, BATT Switch	"AUTO" position
9	PWR/OFF/BATT Switch	"OFF" position
10	RCVR WIDE/MID/NARROW Switch	"MID" position
11	GEN/RCVR Switch	"GEN" position
18	BFO/OFF Switch	"OFF" position
19	AM/FM Switch	"FM" position
23	INT MOD Control	Fully ccw, detent (OFF)

4-7-2 INITIAL FM/AM-1000S/A CONTROL SETTINGS FOR SWEEP GENERATOR/ TRACKING OSCILLOSCOPE OPERATION (CONT'D)

	CONTROL	INITIAL SETTING
24	1 kHz INT MOD Control	Fully ccw, detent (OFF)
25	MODULATION FREQ Hz Thumbwheels	20.0 Hz
27	SWEEP Control	"MODULATION FREQ Hz" position
28	SWEEP Vernier Control	Fully cw, detent (in "CAL" position)
29	AC/OFF/DC Switch	"DC" position
30	EXT V/DIV Vernier Control	Fully cw, detent (in "CAL" position)
31	EXT V/DIV Control	".01 V/DIV" position
35	INTENSITY Control	Fully ccw
36	HORIZONTAL Control	Midrange position
37	FOCUS Control	Midrange position
38	VERT Control	Midrange position
39	ANALY DISPR Control(FM/AM-1000S models only)	Fully ccw, detent
47	DEV/PWR Control	"20 kHz" position

Other FM/AM-1000S/A features related to sweep generator/tracking oscilloscope operation, but not requiring an initial setting:

1	DEVIATION/WATTS Meter
26	SCOPE IN Connector
32	FREQUENCY MHz Thumbwheels

The FM/AM-1000S/A is now ready for sweep generator/tracking oscilloscope operation.

TEST PROCEDURE: ***USING THE FM/AM-1000S/A AS A SWEEP GENERATOR AND TRACKING OSCILLOSCOPE***

TEST OBJECTIVE: To display typical frequency response curve of a circuit under test on FM/AM-1000S/A oscilloscope.

SPECIAL ACCESSORY EQUIPMENT REQ'D:

For Circuits Using Detector:

1 Positive or negative detector (Hewlett Packard 8471A or similar)

1 Coax cable with BNC male connector on both ends

2 Oscilloscope probes (1:1). If CUT has terminating connectors, use 50Ω coax cables with appropriate connectors.

1 BNC female to female adaptor

2 DC blocking capacitors (required only if DC components are present)

For Circuits Using Detector Probe (High Impedance Circuits):

1 Oscilloscope probe (1:1). If CUT has terminating connectors, use 50Ω coax cable with appropriate connectors.

1 Detector probe

1 DC blocking capacitor (required only if DC components are present)

TEST SET-UP DIAGRAM: For Circuits Using Detector:

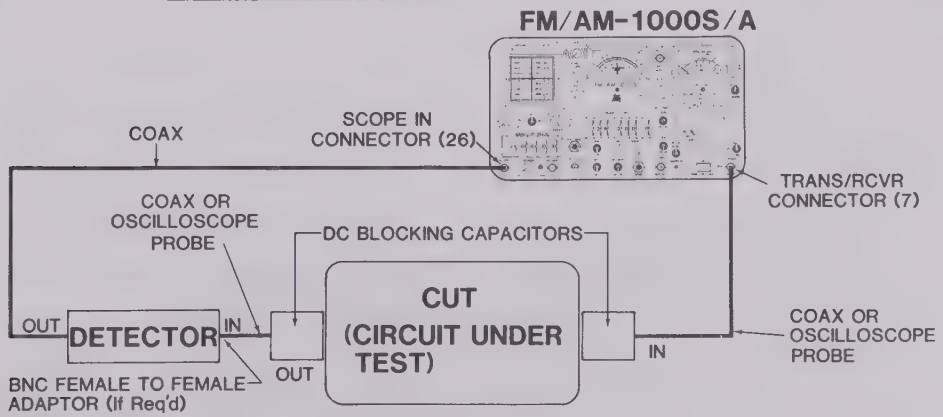


FIGURE 4-31 TEST SET-UP DIAGRAM FOR SWEEP GENERATOR/TRACKING OSCILLOSCOPE OPERATION (USING DETECTOR)

TEST SET-UP
DIAGRAM: (cont'd)

For Circuits Using Detector Probe (High Impedance Circuits):

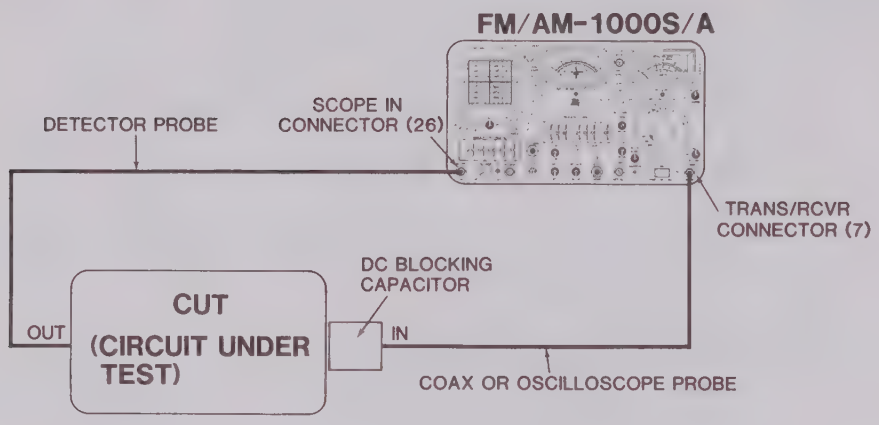
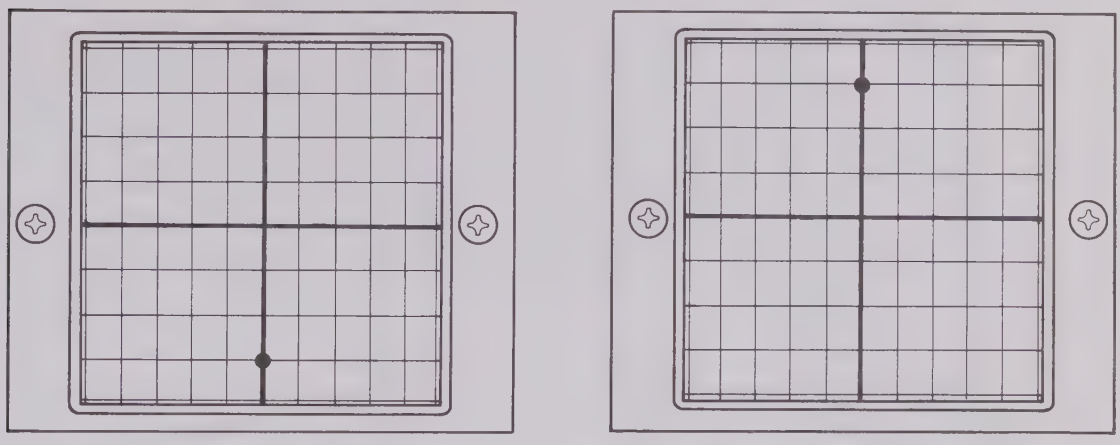


FIGURE 4-32 TEST SET-UP DIAGRAM FOR SWEEP GENERATOR/TRACKING OSCILLOSCOPE OPERATION (USING DETECTOR PROBE)

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for sweep generator/tracking oscilloscope operation as shown in Figure 4-30, page 4-79.
2.	Connect FM/AM-1000S/A to circuit under test (CUT) and required test accessories as shown in appropriate test set-up diagram above.
3.	Apply power to CUT (if applicable).
4.	Apply power to FM/AM-1000S/A.
5.	Adjust INTENSITY Control (35) and FOCUS Control (37) for a sharp visible dot on CRT.

STEP PROCEDURE

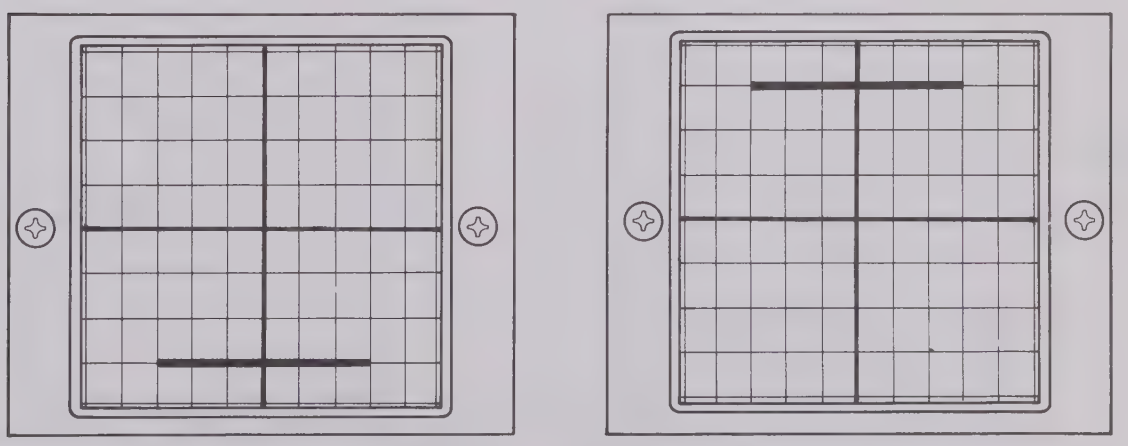
6. Adjust VERT Control (38) and HORIZ Control (36) to position dot three graticule divisions above or below major horizontal axis, along major vertical axis.



USING POSITIVE DETECTOR USING NEGATIVE DETECTOR

FIGURE 4-33 DOT POSITIONED 3 GRATICULE DIVISIONS ABOVE OR BELOW MAJOR HORIZONTAL AXIS, ON MAJOR VERTICAL AXIS

7. Rotate INT MOD Control (23) cw until deviation reading on DEVIATION/WATTS Meter (1) is 20 kHz. Dot on CRT will now become a horizontal trace.



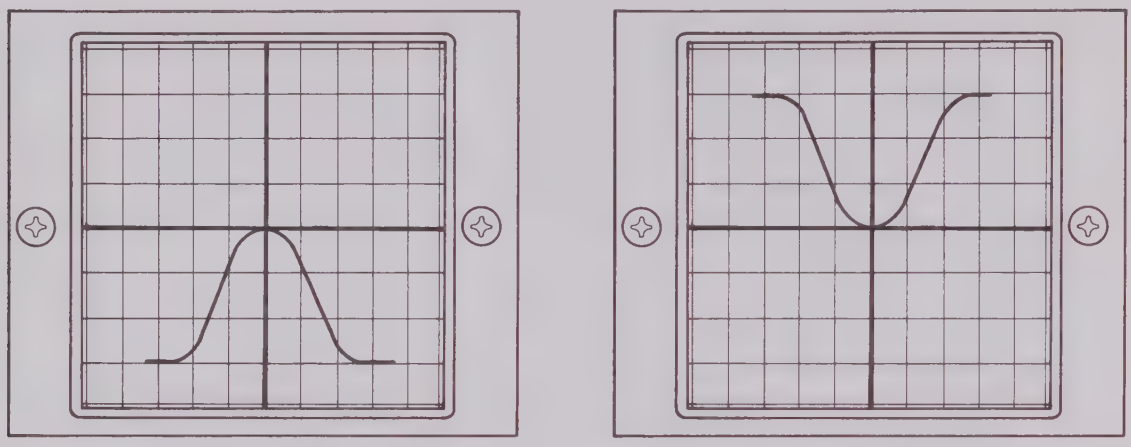
USING POSITIVE DETECTOR USING NEGATIVE DETECTOR

FIGURE 4-34 HORIZONTAL TRACE POSITIONED 3 GRATICULE DIVISIONS ABOVE OR BELOW MAJOR HORIZONTAL AXIS, CENTERED OVER MAJOR VERTICAL AXIS.

8. If trace exhibits any vertical components (i.e. noise), rotate EXT V/DIV Control (31) to ".1 volts/div" position to eliminate those components.

9. Set FREQUENCY MHz Thumbwheels (32) to center of frequency to be swept.

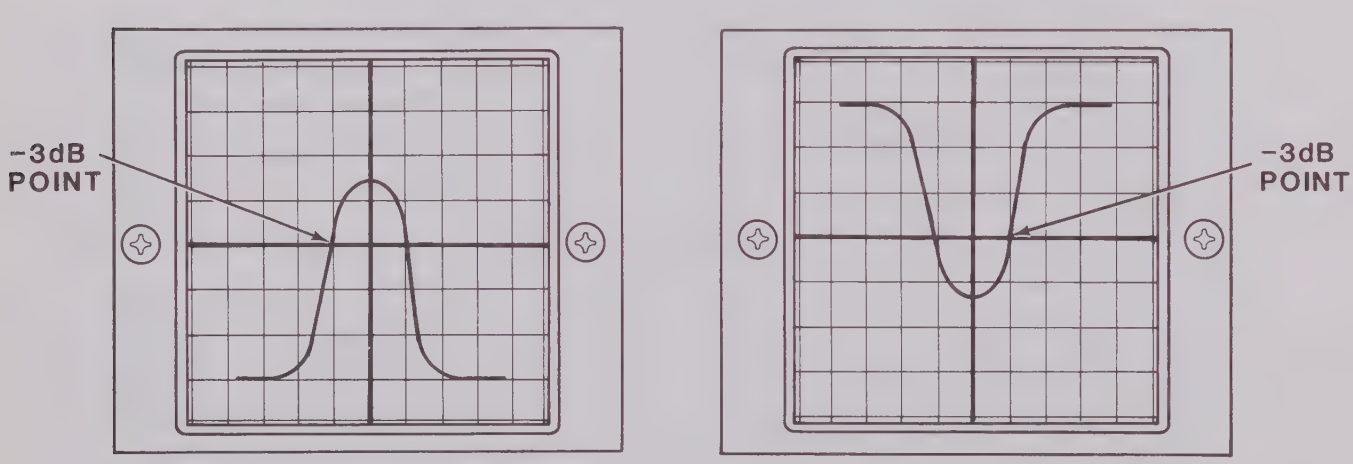
STEP	PROCEDURE
10.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw until peak of displayed waveform rests on major horizontal axis.



USING POSITIVE DETECTOR USING NEGATIVE DETECTOR

FIGURE 4-35 PEAK OF DISPLAYED WAVEFORM RESTING ON MAJOR HORIZONTAL AXIS

11.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw to add 3 dB to signal strength. Oscilloscope is now displaying frequency response curve of CUT. The major horizontal axis on CRT now represents -3 dB point (or half power point) of CUT.



USING POSITIVE DETECTOR USING NEGATIVE DETECTOR

FIGURE 4-36 FREQUENCY RESPONCE OF CURVE OF CUT

STEP	PROCEDURE
11.	(cont'd)

NOTE

- If the 3 dB point above major horizontal axis (below axis when using negative detector) cannot be achieved because of significant attenuation, repeat Step 10 until peak of displayed waveform is aligned with any other horizontal graticule marking above or below major horizontal axis. After repeating Step 11, selected horizontal marking will represent the -3 dB point (or half power point) of frequency response curve.

4-7-4

TEST PROCEDURE: ***MEASURING BANDPASS AND CENTER FREQUENCY OF A BANDPASS CIRCUIT***

TEST OBJECTIVE: N/A

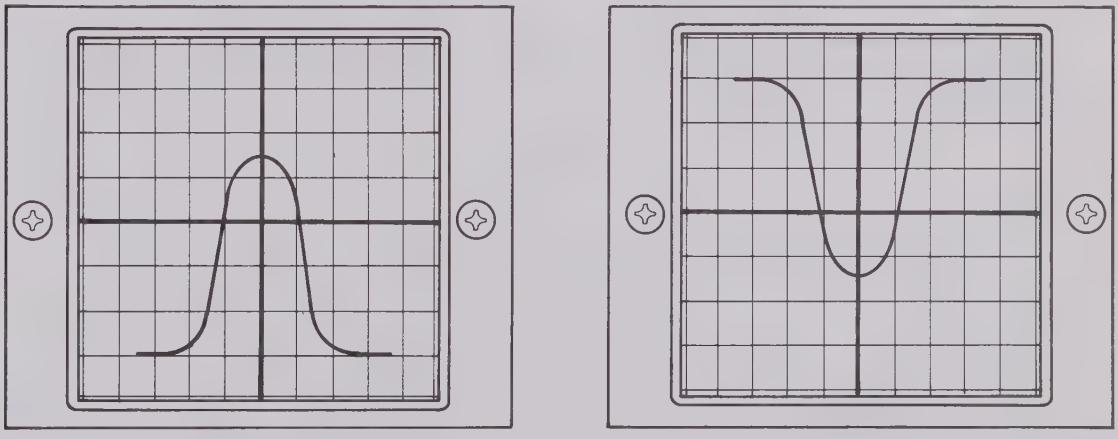
SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP PROCEDURE

1. Perform procedure 4-7-3, titled "USING THE FM/AM-1000S/A AS A SWEEP GENERATOR AND TRACKING OSCILLOSCOPE", on page 4-81.

2. Increment or decrement FREQUENCY MHz Thumbwheels (32) to center peak of bandpass response curve over major vertical axis.



USING POSITIVE DETECTOR USING NEGATIVE DETECTOR

FIGURE 4-37 BANDPASS RESPONSE CURVE CENTERED OVER MAJOR VERTICAL AXIS

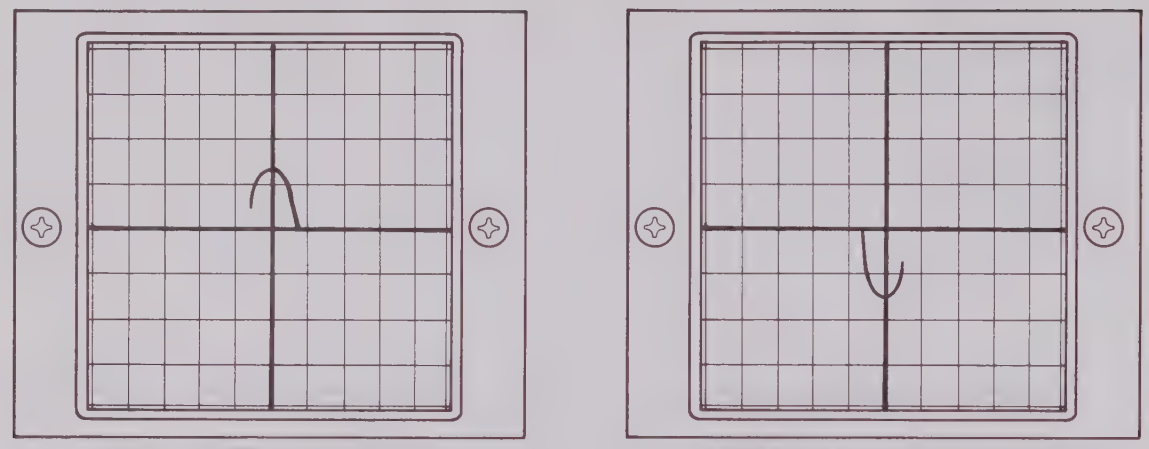
3. Rotate INT MOD Control (23) ccw until one leg of frequency response curve rests on major horizontal axis.

NOTE

- Bandpass response curve may not be totally symmetrical after completing this step (i.e. one leg of curve may be longer than the other).

STEP PROCEDURE

3. (cont'd)



USING POSITIVE DETECTOR USING NEGATIVE DECTECTOR

FIGURE 4-38 BANDPASS RESPONSE CURVE WITH ONE LEG RESTING ON MAJOR HORIZONTAL AXIS

4. Increment or decrement FREQUENCY MHz Thumbwheels (32) until bandpass response curve becomes symmetrical (both legs of curve of equal length).

NOTE

- Legs of frequency response curve may not rest on major horizontal axis after completion of this step.

Present setting of FREQUENCY MHz Thumbwheels (32) represent center frequency of CUT. Record setting.

STEP PROCEDURE

5. Rotate INT MOD Control (23) cw until legs of bandpass response curve again rest on major horizontal axis. The intersection of response curve with major horizontal axis represents -3 dB point (or half power point) of the response curve.

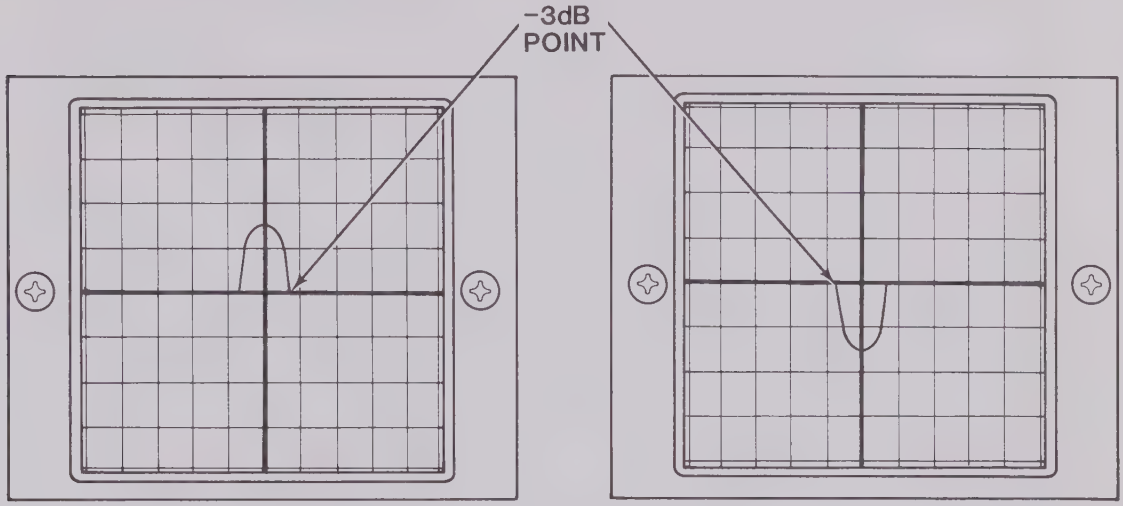


FIGURE 4-39 BANDPASS RESPONSE CURVE WITH LEGS RESTING ON MAJOR HORIZONTAL AXIS

6. To determine bandpass of CUT, observe reading of DEVIATION/ WATTS Meter (1):

   a. If reading on uppermost scale of meter is less than 6 kHz, rotate DEV/PWR Control (47) to "6 kHz" position and proceed to Step 6b. If reading is above 6 kHz, proceed directly to Step 6c.

   b. If reading on middle scale of meter is less than 2 kHz, rotate DEV/PWR Control (47) to "2 kHz" position and proceed to Step 6c. If reading is above 2 kHz, proceed directly to Step 6c.

   c. Record reading of meter; multiply result by 2 to obtain bandpass of CUT in kHz.

4-7-5

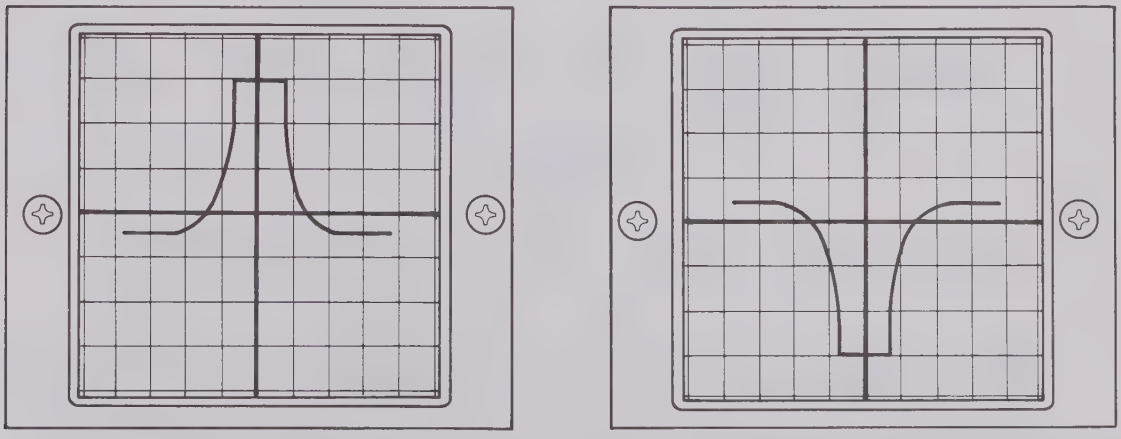
TEST PROCEDURE: ***MEASURING BANDREJECT AND CENTER FREQUENCY OF KNOTCH CIRCUITS***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Perform procedure 4-7-3, titled "USING THE FM/AM-1000S/A AS A SWEEP GENERATOR AND TRACKING OSCILLOSCOPE", on page 4-81.
2.	Increment or decrement FREQUENCY MHz Thumbwheels (32) to center peak of bandreject response curve along major vertical axis.



USING NEGATIVE DETECTOR USING POSITIVE DETECTOR

FIGURE 4-40 BANDREJECT RESPONSE CURVE CENTERED OVER MAJOR VERTICAL AXIS

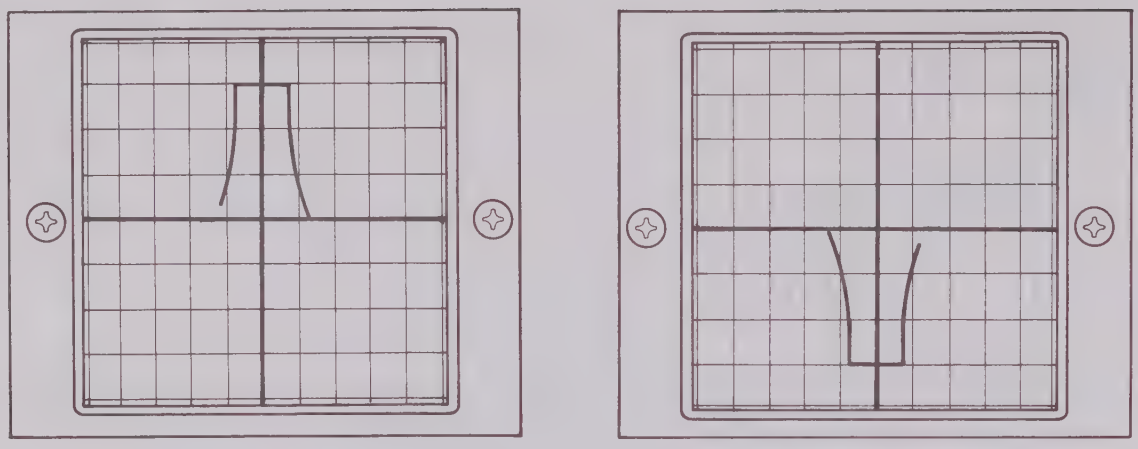
3.	Rotate INT MOD Control (23) ccw until one leg of frequency response curve rests on major horizontal axis.

NOTE

- Bandreject response curve may not be totally symmetrical after completing this step (i.e. one leg of curve may be longer than the other).

STEP PROCEDURE

3. (cont'd)



USING NEGATIVE DETECTOR USING POSITIVE DETECTOR

FIGURE 4-41 BANDREJECT RESPONSE CURVE WITH ONE LEG RESTING ON MAJOR HORIZONTAL AXIS

4. Increment or decrement FREQUENCY MHz Thumbwheels (32) until bandreject response curve becomes symmetrical (both legs of curve of equal length).

NOTE

- Legs of frequency response curve may not rest on major horizontal axis after completion of this step.

Present setting of FREQUENCY MHz Thumbwheels (32) represents center frequency of CUT. Record setting.

5. Rotate INT MOD Control (23) cw until legs of bandreject response curve again rest on major horizontal axis. The intersection of the response curve with major horizontal axis represents -3 dB point (or half power point) of the response curve.

4-5-9

TEST PROCEDURE: ***GENERATING AUDIO TONES OF KNOWN AMPLITUDE***

TEST OBJECTIVE: Setting up FM/AM-1000S dual tone generator for audio signal injection into UUT.

SPECIAL ACCESSORY EQUIPMENT REQ'D:

1 BNC tee connector.

1 50 ohm coax cable with male BNC connectors.

1 50 ohm coax cable with male BNC connector on one end and appropriate UUT connector on the other end.

1 DC blocking capacitor.

TEST SET-UP DIAGRAM:

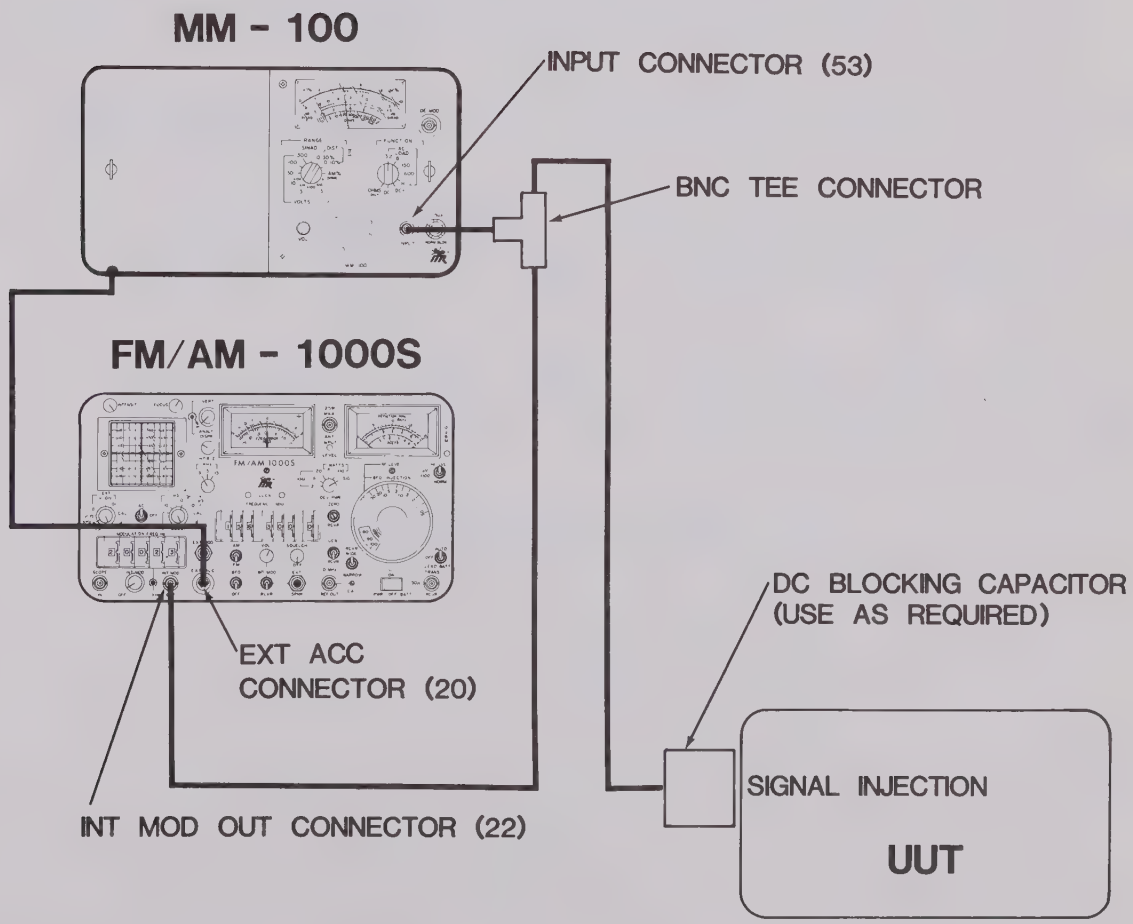


FIGURE 4-6 TEST SET-UP DIAGRAM FOR GENERATING AUDIO TONES OF KNOWN AMPLITUDE

STEP	PROCEDURE

1. Set FM/AM-1000S controls as follows:

CONTROL	INITIAL SETTING
PWR/OFF/BATT Switch (9)	"OFF" position
INT MOD Control (23)	Full ccw, detent OFF
1 kHz INT MOD Control (24)	Full ccw, detent OFF
MODULATION FREQ Hz Thumbwheels (25)	0000.0 Hz

2. Set MM-100 controls to initial settings; refer to Table 4-2.
3. Connect UUT in accordance with Test Set-up Diagram.
4. Apply power to the FM/AM-1000S and UUT.
5. Place UUT into the proper mode to accept the signal injection.
6. Set MODULATION FREQ Hz Thumbwheels (25) to desired tone.
7. Set RANGE Control (58) to desired range (10 V position or less).
8. Rotate INT MOD Control (23) until desired audio level is displayed on METER (49).

STEP PROCEDURE

5. (cont'd)

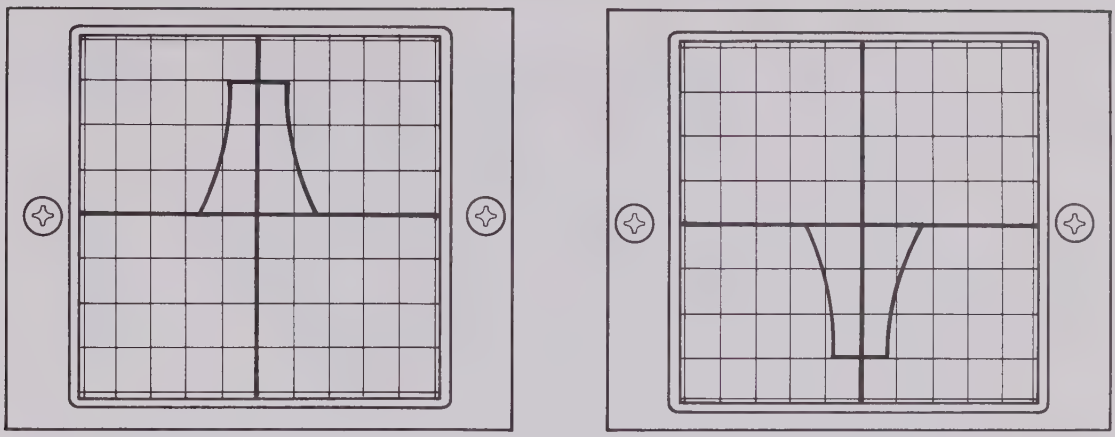


FIGURE 4-42 BANDREJECT RESPONSE CURVE WITH LEGS RESTING ON MAJOR HORIZONTAL AXIS

6. To determine bandreject of CUT, observe reading of DEVIATION/ WATTS Meter (1):

   a. If reading on uppermost scale of meter is less than 6 kHz, rotate DEV/PWR Control (47) to "6 kHz" position and proceed to Step 6b. If reading is above 6 kHz, proceed directly to Step 6c.

   b. If reading on middle scale is less than 2 kHz, rotate DEV/PWR Control (47) to "2 kHz" position and proceed to Step 6c. If reading is above 2 kHz, proceed directly to Step 6c.

   c. Record reading of meter; multiply result by 2 to obtain bandreject of CUT in kHz.

TEST PROCEDURE: ***MEASURING CUT-OFF FREQUENCY OF LOWPASS CIRCUITS***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D:

For Circuits Using Detector:

1 Positive or negative detector (Hewlett Packard 8471A or similar)

1 Coax cable with BNC male connector on both ends

2 Oscilloscope probes (1:1). If CUT has terminating connectors, use 50Ω coax cables with appropriate connectors.

1 BNC female to female adaptor

2 DC blocking capacitors (required only if DC components are present)

For Circuits Using Detector Probe (High Impedance Circuits):

1 Oscilloscope probe (1:1). If CUT has terminating connectors, use 50Ω coax cable with appropriate connectors

1 Detector probe

1 DC blocking capacitor (required only if DC components are present)

TEST SET-UP DIAGRAM: For Circuits Using Detector:

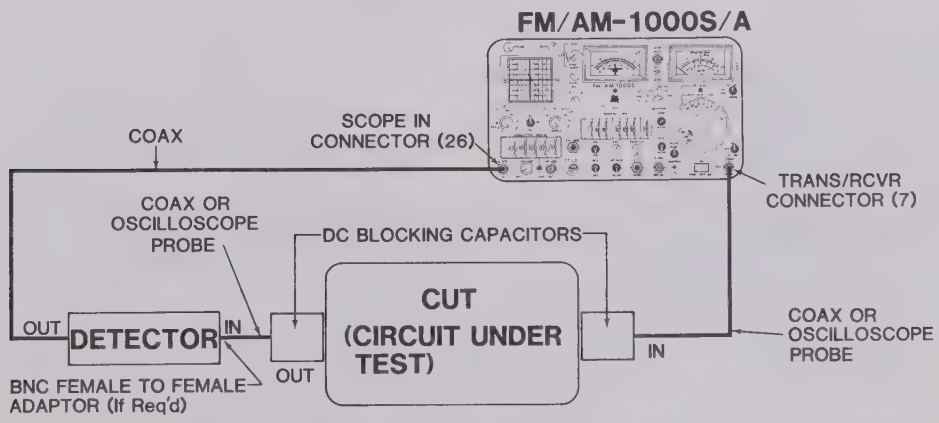


FIGURE 4-43 TEST SET-UP DIAGRAM FOR MEASURING CUT-OFF FREQUENCY OF LOWPASS CIRCUITS (USING DETECTOR)

TEST SET-UP
DIAGRAM: For Circuits Using Detector Probes (High Impedance Circuits):

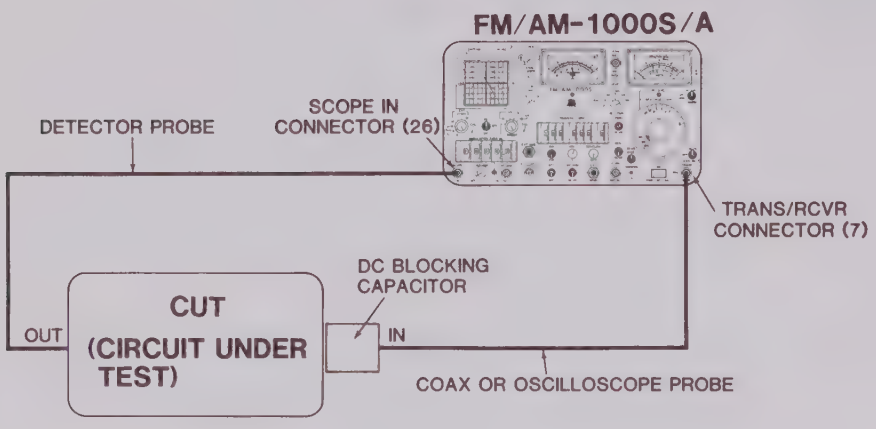
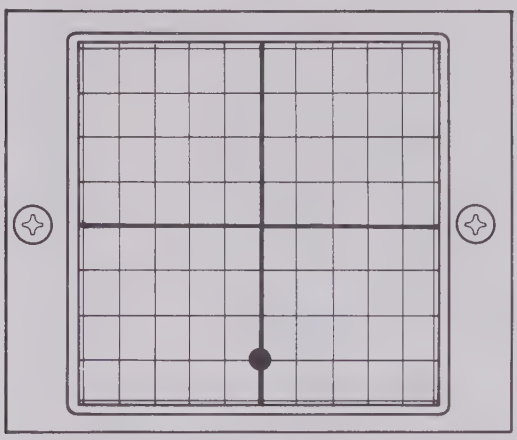


FIGURE 4-44 TEST SET-UP DIAGRAM FOR MEASURING CUT-OFF FREQUENCY OF LOWPASS CIRCUITS (USING DETECTOR PROBE)

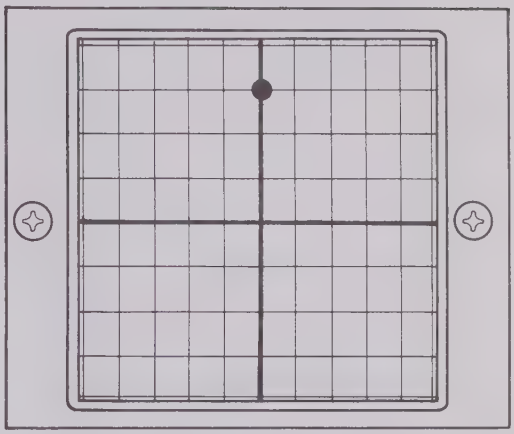
STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for sweep generator/tracking oscilloscope operation as shown in Figure 4-30, page 4-79.
2.	Connect FM/AM-1000S/A to circuit under test (CUT) and required test accessories as shown in appropriate test set-up diagram above.
3.	Apply power to CUT (if applicable).
4.	Apply power to FM/AM-1000S/A.
5.	Adjust INTENSITY Control (35) and FOCUS Control (37) for a sharp visible dot on CRT.
6.	Adjust VERT Control (38) and HORIZ Control (36) to position dot three graticule divisions above or below major horizontal axis, along major vertical axis.

STEP PROCEDURE

6. (cont'd)



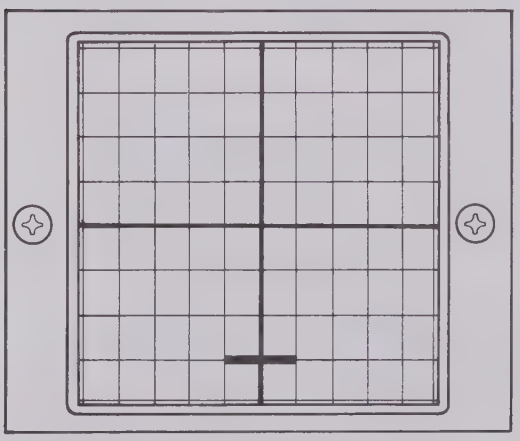
USING POSITIVE DETECTOR



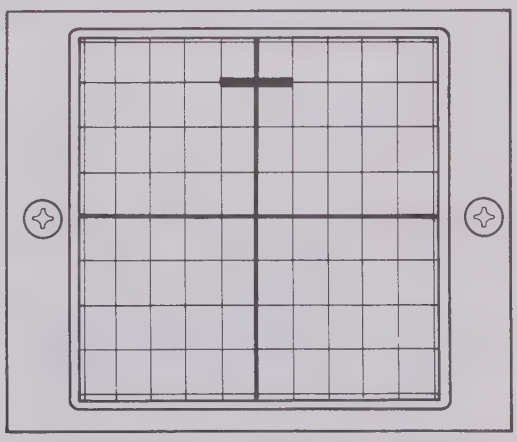
USING NEGATIVE DETECTOR

FIGURE 4-45 DOT POSITIONED 3 GRATICULE DIVISIONS ABOVE OR BELOW MAJOR HORIZONTAL AXIS , CENTERED OVER MAJOR VERTICAL AXIS

7. Rotate INT MOD Control (23) cw until deviation reading on DEVIATION/WATTS Meter (1) is 5 kHz. Dot on CRT will now become a horizontal trace.



USING NEGATIVE DETECTOR



USING POSITIVE DETECTOR

FIGURE 4-46 HORIZONTAL TRACE POSITIONED 3 GRATICULE DIVISIONS ABOVE OR BELOW MAJOR HORIZONTAL AXIS,CENTERED OVER MAJOR VERTICAL AXIS

8. If trace exhibits any vertical components (e.g. noise), rotate EXT V/DIV Control (31) ccw to ".1 volts/div" position to eliminate those components.

STEP	PROCEDURE
9.	Set FREQUENCY MHz Thumbwheels (32) to a frequency substantially lower than cut-off frequency of CUT.
10.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw until scope trace becomes aligned with horizontal axis.

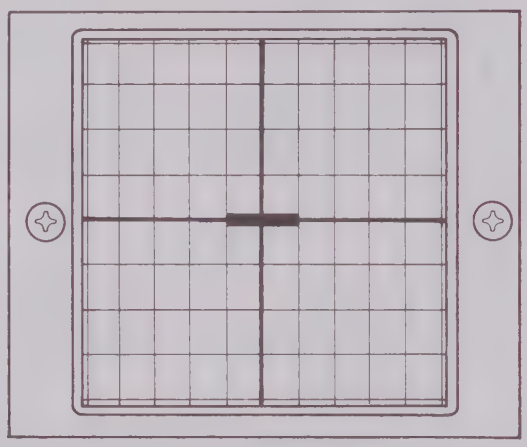


FIGURE 4-47 HORIZONTAL TRACE ALIGNED WITH MAJOR HORIZONTAL AXIS (USING POSITIVE & NEGATIVE DETECTOR)

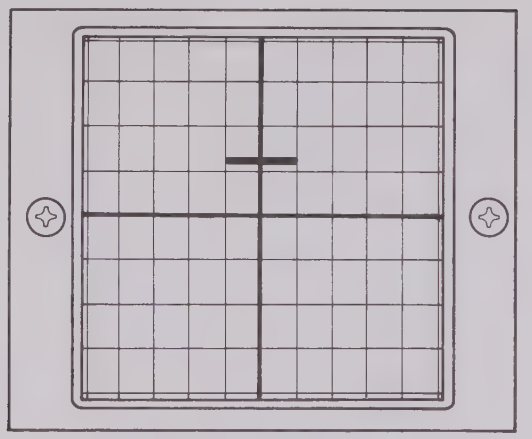
11. Rotate RF LEVEL/BFO INJECTION Dial (5) cw to add 3 dB to signal strength. The major horizonal axis now represents -3 dB point (or half power point) of CUT.

NOTE

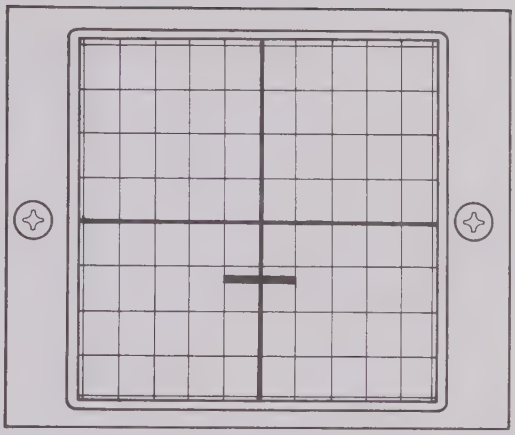
- If the 3 dB point above major horizontal axis (below axis when using negative detector) cannot be achieved because of significant attenuation, repeat Step 10 until horizontal trace is aligned with any other horizontal graticule marking above or below major horizontal axis. After repeating Step 11, selected horizontal marking will represent the -3 dB point (or half power point) of frequency response curve.

STEP PROCEDURE

11. (cont'd)



USING POSITIVE DETECTOR



USING NEGATIVE DETECTOR

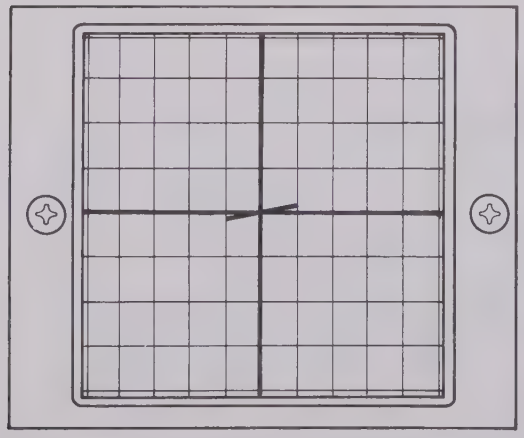
FIGURE 4-48 POSITION OF HORIZONTAL TRACE AFTER ADDING 3dB TO SIGNAL STRENGTH

12. Set FREQUENCY MHz Thumbwheels (32) to approximate cut-off frequency of CUT.

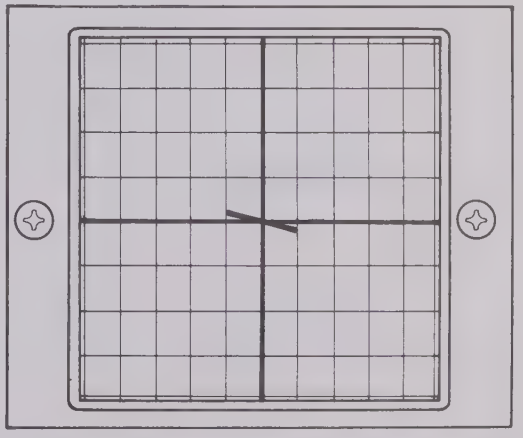
13. Rotate FREQUENCY MHz Thumbwheels (32) as indicated below to position frequency response curve at point where major vertical and horizontal axes intersect:

a. If horizontal trace (or section of frequency response curve) is above a major horizontal axis, increment FREQUENCY MHz Thumbwheels (32).

b. If horizontal trace (or section of frequency response curve) is below major horizontal axis, decrement FREQUENCY MHz Thumbwheels (32).



USING POSITIVE DETECTOR



USING NEGATIVE DETECTOR

FIGURE 4-49 HORIZONTAL TRACE (OR SECTION OF FREQUENCY RESPONSE CURVE) POSITIONED AT INTERSECTION OF MAJOR AXES

STEP	PROCEDURE
14.	Present setting of FREQUENCY MHz Thumbwheels represents cut-off frequency of CUT.

4-7-7

TEST PROCEDURE: ***MEASURING CUT-OFF FREQUENCY OF HIGH PASS CIRCUITS***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D:

For Circuits Using Detector:

1 Positive or negative detector (Hewlett Packard 8471A or similar)

1 Coax cable with BNC male connector on both ends

2 Oscilloscope probes (1:1). If CUT has terminating connectors, use 50Ω coax cables with appropriate connectors.

1 BNC female to female adaptor

2 DC blocking capacitors (required only if DC components are present)

For Circuits Using Detector Probe (High Impedance Circuits):

1 Oscilloscope probe (1:1). If CUT has terminating connectors, use 50Ω coax cable with appropriate connectors

1 Detector probe

1 DC blocking capacitor (required only if DC components are present)

TEST SET-UP DIAGRAM: For Circuits Using Detector:

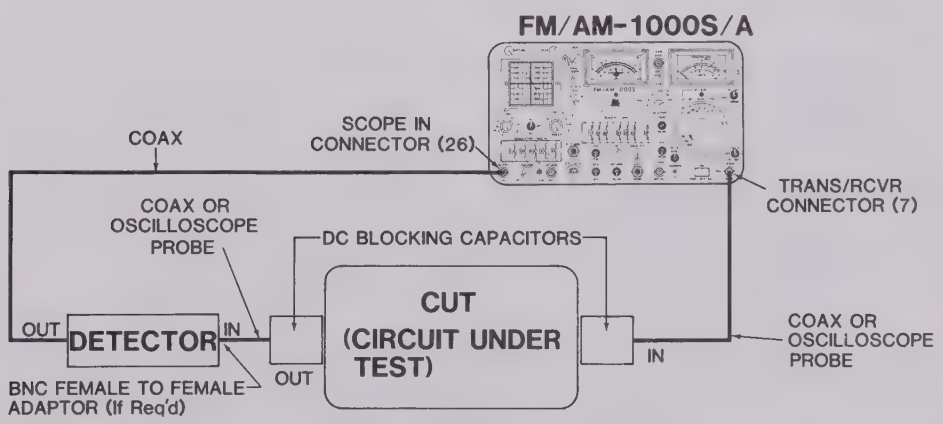


FIGURE 4-50 TEST SET-UP DIAGRAM FOR MEASURING CUT-OFF FREQUENCY OF HIGHPASS CIRCUITS (USING DETECTOR)

TEST SET-UP
DIAGRAM: For Circuits Using Detector Probe (High Impedance Circuits):

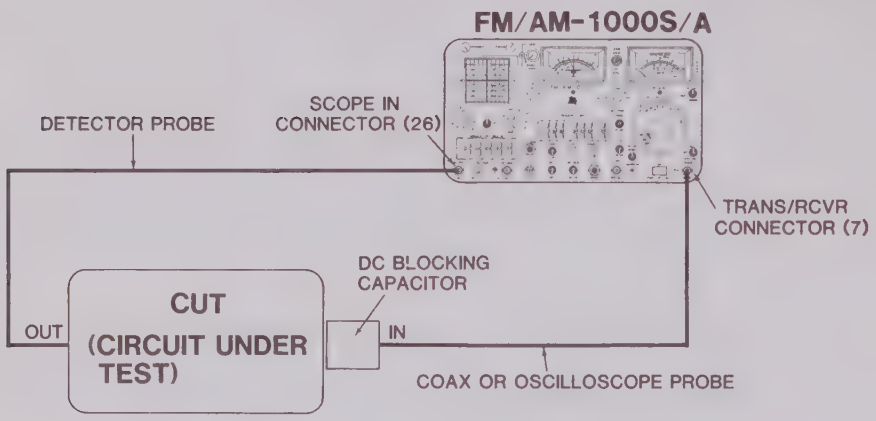
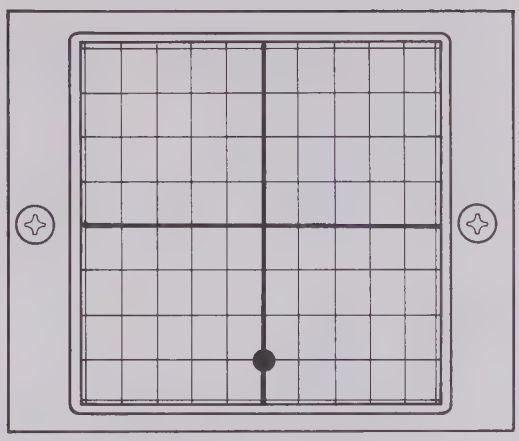


FIGURE 4-51 TEST SET-UP DIAGRAM FOR MEASURING CUT-OFF FREQUENCY OF HIGHPASS CIRCUITS (USING DECTOR PROBE)

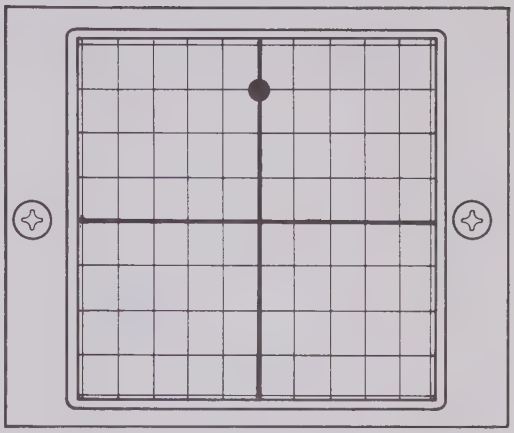
STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for sweep generator/tracking oscilloscope operation as shown in Figure 4-30, page 4-79.
2.	Connect FM/AM-1000S/A to circuit under test (CUT) and required test accessories as shown in appropriate test set-up diagram above.
3.	Apply power to CUT (if applicable).
4.	Apply power to FM/AM-1000S/A.
5.	Adjust INTENSITY Control (35) and FOCUS Control (37) for a sharp visible dot on CRT.
6.	Adjust VERT Control (38) and HORIZ Control (36) to position dot three graticule divisions above or below major horizontal axis, along major vertical axis.

STEP PROCEDURE

6. (cont'd)



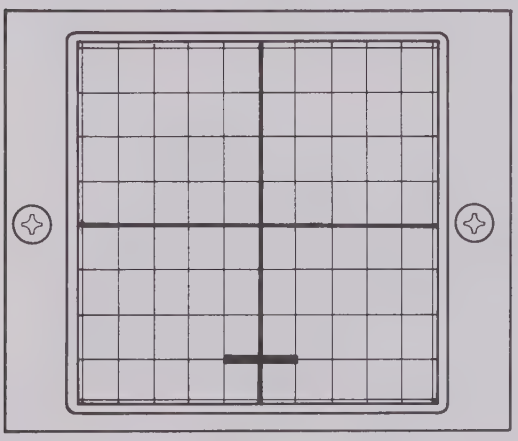
USING POSITIVE DETECTOR



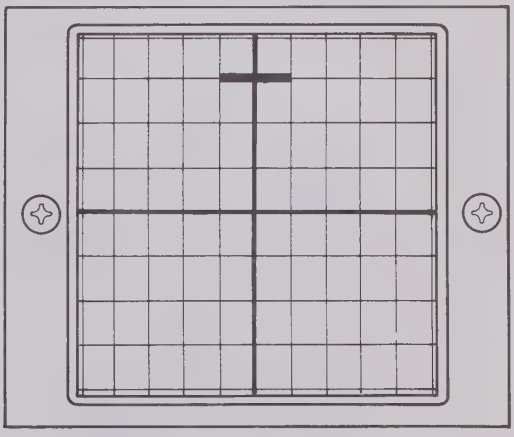
USING NEGATIVE DETECTOR

FIGURE 4-52 DOT POSITIONED 3 GRATICULE DIVISIONS ABOVE OR BELOW MAJOR HORIZONTAL AXIS, ON MAJOR VERTICAL AXIS

7. Rotate INT MOD Control (23) cw until deviation reading on DEVIATION/WATTS Meter (1) is 5 kHz. Dot on CRT will now become a horizontal trace.



USING POSITIVE DETECTOR



USING NEGATIVE DETECTOR

FIGURE 4-53 HORIZONTAL TRACE POSITIONED 3 GRATICULE DIVISIONS ABOVE OR BELOW MAJOR HORIZONTAL AXIS , CENTERED OVER MAJOR VERTICAL AXIS

8. If trace exhibits any vertical components (e.g. noise), rotate EXT V/DIV Control (31) ccw to ".1 volts/div" position to eliminate those components.

STEP	PROCEDURE
9.	Set FREQUENCY MHz Thumbwheels (32) to a frequency substantially higher than cut-off frequency of CUT.
10.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw until scope trace becomes aligned with major horizontal axis.

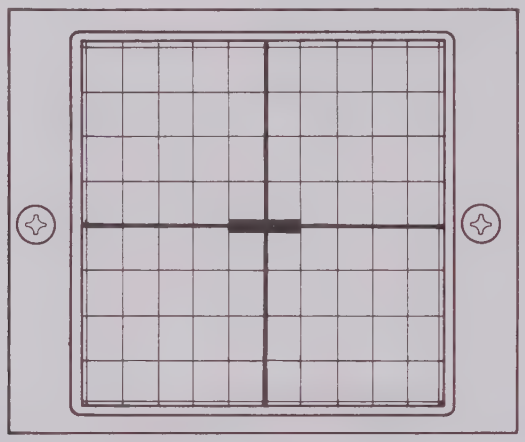


FIGURE 4-54 HORIZONTAL TRACE ALIGNED WITH MAJOR HORIZONTAL AXIS (USING POSITIVE AND NEGATIVE DETECTOR)

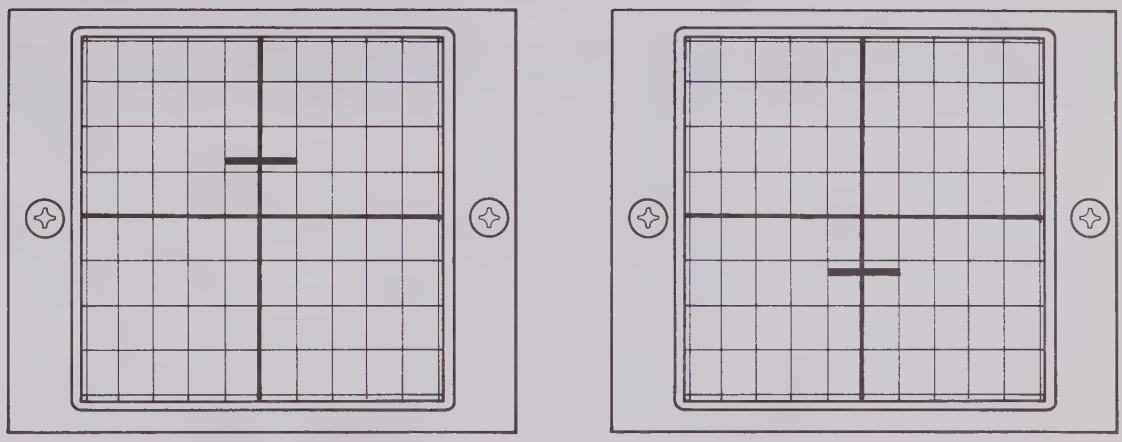
11.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw to add 3 dBm to signal strength. The major horizontal axis on CRT now represents -3 dB point (or half power point) of CUT.

NOTE

- If the 3 dB point above major horizontal axis (below axis when using negative detector) cannot be achieved because of significant attenuation, repeat Step 10 until horizontal trace is aligned with any other horizontal graticule marking above or below major horizontal axis. After repeating Step 11, selected horizontal marking will represent the -3 dB point (or half power point) of frequency response curve.

STEP PROCEDURE

11. (cont')



USING POSITIVE DETECTOR USING NEGATIVE DETECTOR

FIGURE 4-55 POSITION OF HORIZONTAL TRACE AFTER ADDING 3dB

12. Set FREQUENCY MHz Thumbwheels (32) to approximate cut-off frequency of CUT.

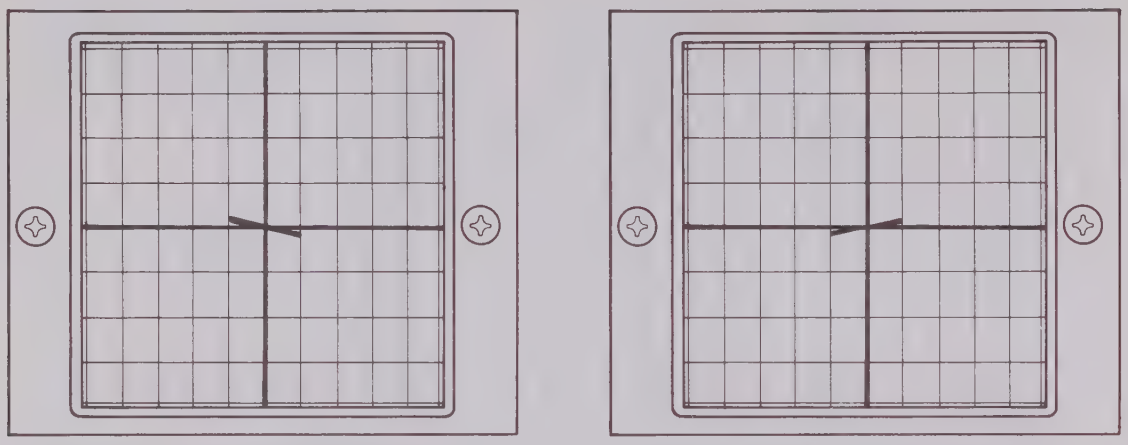
13. Rotate FREQUENCY MHz Thumbwheels (32) as indicated below to position frequency response curve at point where major vertical and horizontal axes intersect:

    a. If horizontal trace (or section of frequency response curve) is above major horizontal axis, decrement FREQUENCY MHz Thumbwheels (32).

    b. If horizontal trace (or section of frequency response curve) is below major horizontal axis, increment FREQUENCY MHz Thumbwheels (32).

STEP PROCEDURE

13. (cont'd)



USING POSITIVE DETECTOR USING NEGATIVE DETECTOR

FIGURE 4-56 HORIZONTAL TRACE (OR SECTION OF FREQUENCY RESPONSE CURVE) POSITIONED AT INTERSECTION OF MAJOR AXES

14. Present setting of FREQUENCY MHz Thumbwheels represents cut-off frequency of CUT.

4-8 GENERAL RECEIVER TESTS

4-8-1 GENERAL

This section contains an assortment of the more common tests to be used in evaluating AM/FM receiver performance using the FM/AM-1000S/A. The tests included were selected on the basis of appropriateness, wide ranging applicability and minimal support equipment required to complete the tests. Reference the "RECEIVER ALIGNMENT FLOWCHART" contained in Section 5 of this manual for the recommended sequence in which these tests should be performed.

The test procedures contained in this section are:

Applicable to AM or FM receivers:

4-8-2 OSCILLATOR FREQUENCY MEASUREMENT (Using FM/AM-1000S)
4-8-2A OSCILLATOR FREQUENCY MEASUREMENT (Using FM/AM-1000A)
4-8-3 MEASURING RF SECTION BANDPASS AND CENTER FREQUENCY
4-8-4 MEASURING BANDPASS AND CENTER FREQUENCY OF AN IF STRIP
4-8-5 MEASURING RECEIVER BANDPASS AND CENTER FREQUENCY (For bandpasses less than 40 kHz)
4-8-6 MEASURING RECEIVER BANDPASS AND CENTER FREQUENCY (For bandpasses greater than 40 kHz)
4-8-7 MEASURING SQUELCH THRESHOLD AND DIFFERENTIAL (For receivers with fixed squelch control.)
4-8-8 MEASURING SQUELCH THRESHOLD AND DIFFERENTIAL (For receivers with variable squelch control.)
4-8-9 MEASURING AGC ACTION
4-8-10 MEASURING RECEIVER SENSITIVITY

Applicable to FM receivers only:

4-8-11 MEASURING 20 dB QUIETING
4-8-12 MEASURING 12 dB SINAD SENSITIVITY
4-8-13 MEASURING MAXIMUM RECEIVABLE DEVIATION

TEST PROCEDURE: ***OSCILLATOR FREQUENCY MEASUREMENT (AM/FM RCVR) - USING FM/AM-1000S***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: RF Pickup or "Sniffer" Cable (See Appendix G for cable construction procedure.)

TEST SET-UP DIAGRAM:

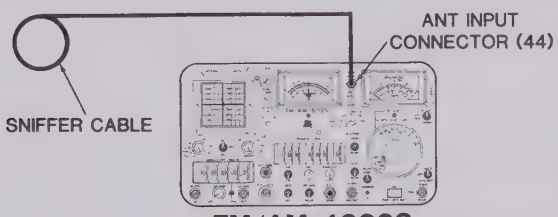


FIGURE 4-57 TEST SET-UP DIAGRAM FOR OSCILLATOR FREQUENCY MEASUREMENT

STEP	PROCEDURE
1.	Set FM/AM-1000S controls for receiver operation as shown in Figure 4-28, page 4-63.
2.	Set FM/AM-1000S controls for spectrum analyzer operation as shown in Figure 4-16, page 4-33.
3.	Apply power to FM/AM-1000S.
4.	Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately for a sharp visible trace display.

NOTE

- Warm-up time of CRT is approximately 30 seconds from a "cold" start-up; trace display will not become visible until CRT achieves warm-up.

5.	Set FREQUENCY MHz Thumbwheels (32) to within ±5 MHz of frequency of local oscillator under test.

STEP PROCEDURE

6. Connect RF pickup or "sniffer" cable to ANT INPUT Connector (44).

CAUTION

- MAXIMUM CONTINUOUS INPUT TO THIS CONNECTOR MUST NOT EXCEED .25 W.
- MAXIMUM INPUT IS -30 dBm FOR PROPER SPECTRUM ANALYZER OPERATION (SIGNALS ABOVE -30 dBm MAY CAUSE SPURIOUS SIGNALS TO BE GENERATED AND DISPLAYED BY FM/AM-1000S.)

7. Place loop of sniffer cable in close proximity to oscillator being tested in UUT.

8. Rotate ANALY DISPR Control (39) fully ccw and locate oscillator spectrum on spectrum analyzer display.

9. Increment or decrement FREQUENCY MHz Thumbwheels (32) to align oscillator spectrum with major vertical axis.

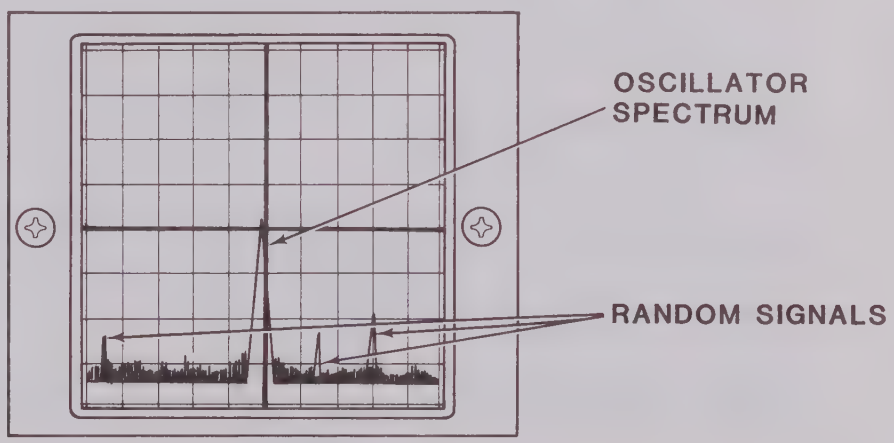


FIGURE 4-58 OSCILLATOR SPECTRUM ALIGNED WITH MAJOR VERTICAL AXIS

10. Shut off power to UUT and observe spectrum analyzer to confirm that the spectrum previously aligned with major vertical axis disappears.

a. If spectrum disappears when power to UUT is shut off, spectrum is confirmed to be a product of UUT; proceed to Step 13.

b. If spectrum does not disappear, its origin is confirmed to be from a source other than UUT; proceed to Step 12.

STEP	PROCEDURE
11.	Reapply power to UUT and observe spectrums which reappear on spectrum analyzer. Those spectrums which reappear are produced by UUT. Repeat Step 9 to locate and align spectrum of oscillator under test with major vertical axis.
12.	Rotate ANALY DISPR Control (39) fully ccw, short of detent position.
13.	Realign local oscillator spectrum with major vertical axis by incrementing or decrementing FREQUENCY MHz Thumbwheels (32).
14.	While carefully observing FREQ ERROR Meter (41), increment or decrement FREQUENCY MHz Thumbwheels (32) to center FREQ ERROR Meter (41) at zero.
15.	Rotate 1.5/5/15 kHz Control (33) to "5 kHz" position and increment or decrement FREQUENCY MHz Thumbwheels (32) to center FREQ ERROR Meter (41) at zero.
16.	Rotate 1.5/5/15 kHz Control (33) to "1.5 kHz" position and increment or decrement FREQUENCY MHz Thumbwheels (32) to center FREQ ERROR Meter (41) at zero.
	a. Present setting of FREQUENCY MHz Thumbwheels (32) represents frequency of oscillator under test.

4-8-2A

TEST PROCEDURE: ***OSCILLATOR FREQUENCY MEASUREMENT (AM/FM RCVR) - USING FM/AM-1000A***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: Same as for Test Procedure 4-8-2

TEST SET-UP DIAGRAM: Same as for Test Procedure 4-8-2

STEP	PROCEDURE
1.	Set FM/AM-1000A controls for receiver operation as shown in Figure 4-28, page 4-63.
2.	Apply power to FM/AM-1000A.
3.	Set FREQUENCY MHz Thumbwheels (32) to within ±15 kHz of frequency of local oscillator being tested. (Refer to UUT manufacturer's specifications for local oscillator frequency.)
4.	Connect RF pickup or "sniffer" cable to ANT INPUT Connector (44).

CAUTION

- MAXIMUM CONTINUOUS INPUT TO THIS CONNECTOR MUST NOT EXCEED .25 W.

5. Place loop of sniffer cable in close proximity to oscillator being tested in UUT.

6. While carefully observing FREQ ERROR Meter (41), increment or decrement FREQUENCY MHz Thumbwheels (32) to center FREQ ERROR Meter (41) at zero.

7. Rotate 1.5/5/15 kHz Control (33) to "5 kHz" position and increment or decrement FREQUENCY MHz Thumbwheels (32) to center FREQ ERROR Meter (41) at zero.

8. Rotate 1.5/5/15 kHz Control (33) to "1.5 kHz" position and place RCVR WIDE/MID/NARROW Switch (10) to "NARROW" position.

9. Increment or decrement FREQUENCY MHz Thumbwheels (32) to center FREQ ERROR Meter (41) at zero.

   a. Present setting of FREQUENCY MHz Thumbwheels (32) represents frequency of oscillator under test.

TEST PROCEDURE: ***MEASURING RF SECTION BANDPASS AND CENTER FREQUENCY (AM/FM RCVR)***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D:

For Circuits Using Detector:

1 Positive or negative detector (Hewlett Packard 8471A or similar)

1 Coax cable with BNC male connector on both ends

2 Oscilloscope probes (1:1). If CUT has terminating connectors, use 50Ω coax cables with appropriate connectors.

1 BNC female to female adaptor

2 DC blocking capacitors (required only if DC components are present)

For Circuits Using Detector Probe (High Impedance Circuits):

1 Oscilloscope probe (1:1). If CUT has terminating connectors, use 50Ω coax cable with appropriate connectors

1 Detector probe

1 DC blocking capacitor (required only if DC components are present)

TEST SET-UP DIAGRAM: For Circuits Using Detector:

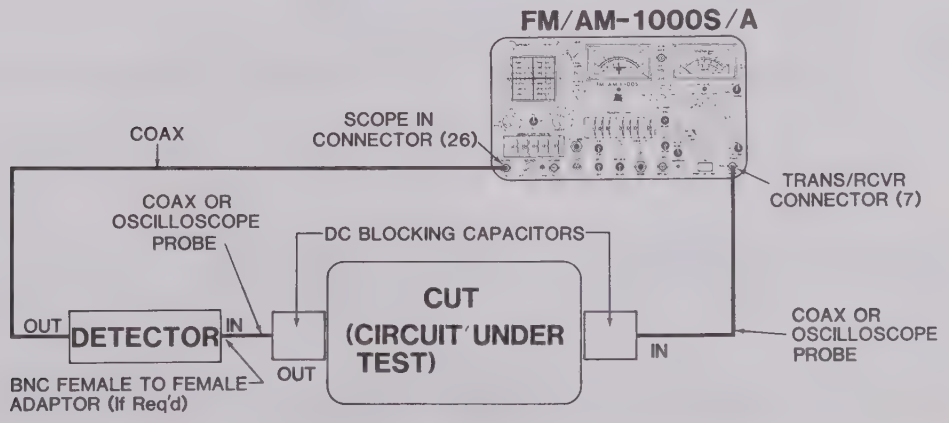


FIGURE 4-59 TEST SET-UP DIAGRAM FOR MEASURING RF SECTION BANDPASS AND CENTER FREQUENCY (USING DETECTOR)

TEST SET-UP
DIAGRAM: (cont'd)

For Circuits Using Detector Probe (High Impedance Circuits):

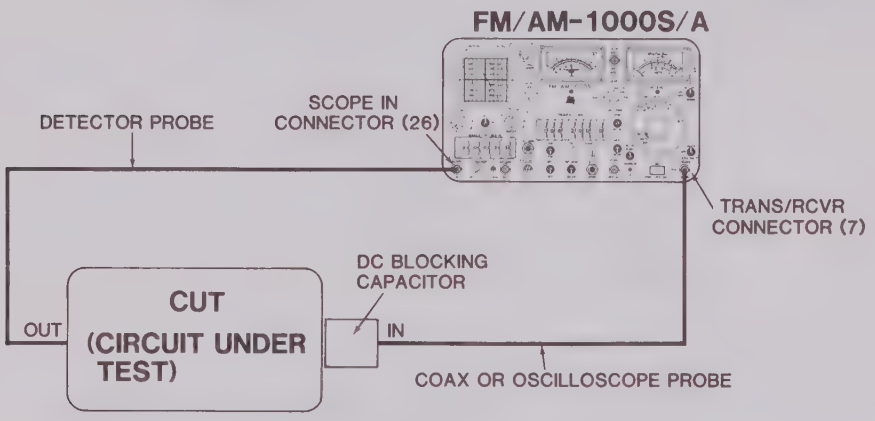


FIGURE 4-60 TEST SET-UP DIAGRAM FOR MEASURING RF SECTION BANDPASS AND CENTER FREQUENCY (USING DETECTOR PROBE)

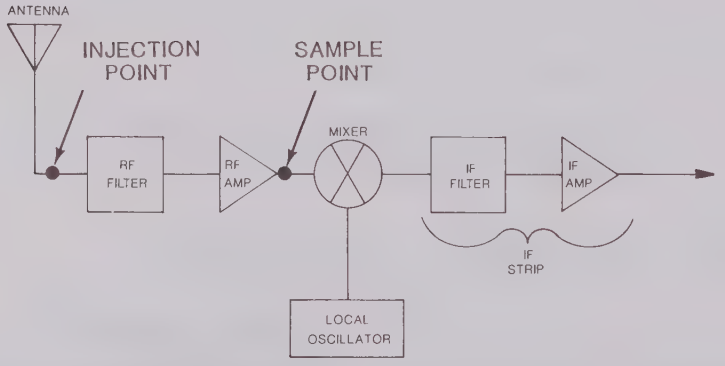


FIGURE 4-61 UUT INJECTION AND SAMPLE POINTS (SINGLE CONVERSION RECEIVER)

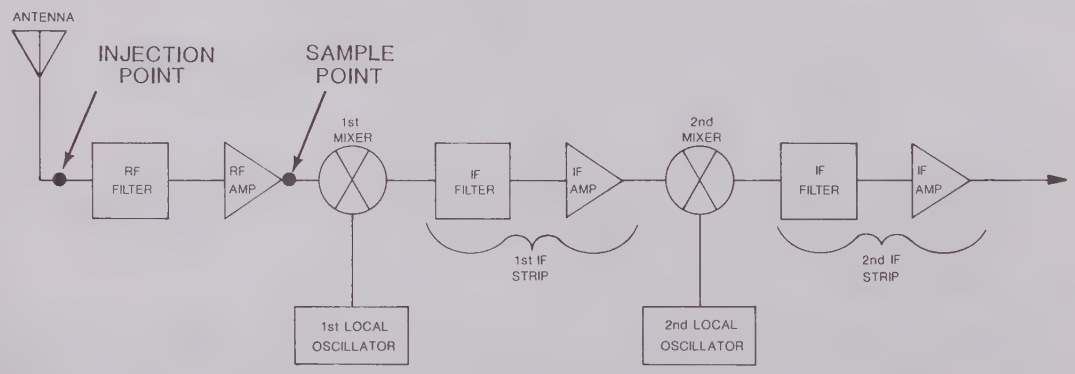
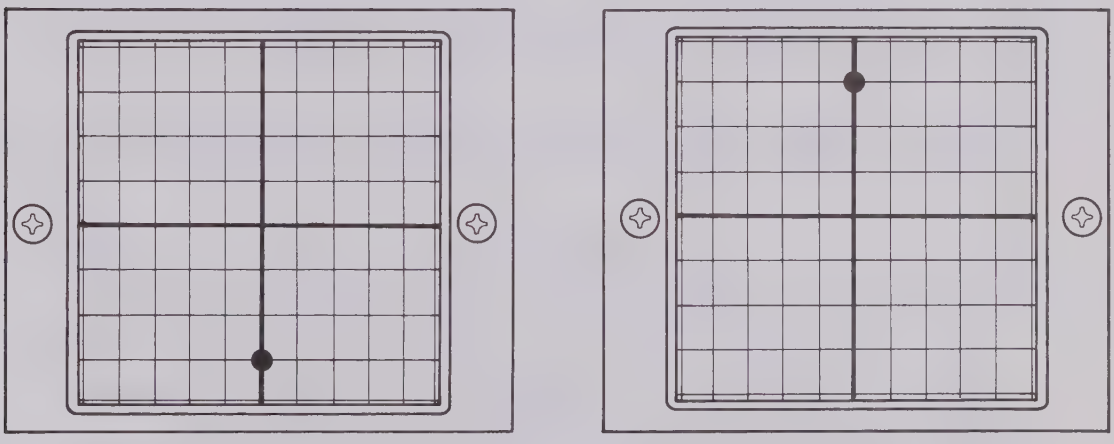


FIGURE 4-62 UUT INJECTION AND SAMPLE POINTS (DUAL CONVERSION RECEIVER)

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for sweep generator/tracking oscilloscope operation as shown in Figure 4-30, page 4-79.
2.	Connect FM/AM-1000S/A to required test accessory equipment and circuit under test within UUT as shown in appropriate test set-up diagram at beginning of this procedure.
3.	Apply power to UUT.
4.	Apply power to FM/AM-1000S/A.
5.	Adjust INTENSITY Control (35) and FOCUS Control (37) for a sharp visible dot on CRT.
6.	Adjust VERT Control (38) and HORIZ Control (36) to position dot three graticule divisions above or below major horizontal axis, along major vertical axis.



USING POSITIVE DETECTOR USING NEGATIVE DETECTOR

FIGURE 4-63 DOT POSITIONED 3 GRATICULE DIVISIONS ABOVE OR BELOW MAJOR HORIZONTAL AXIS , ON MAJOR VERTICAL AXIS

7.	Rotate INT MOD Control (23) cw until deviation reading on DEVIATION/WATTS Meter (1) is 5 kHz. Dot on CRT will now become a horizontal trace.
8.	If trace exhibits any vertical components (e.g. noise) rotate EXT V/DIV Control (31) ccw to ".1 volts/div" position to eliminate those components.
9.	Set FREQUENCY MHz Thumbwheels (32) to center of frequency being swept (approximate center of bandpass).

STEP	PROCEDURE
10.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw until trace becomes aligned with major horizontal axis.

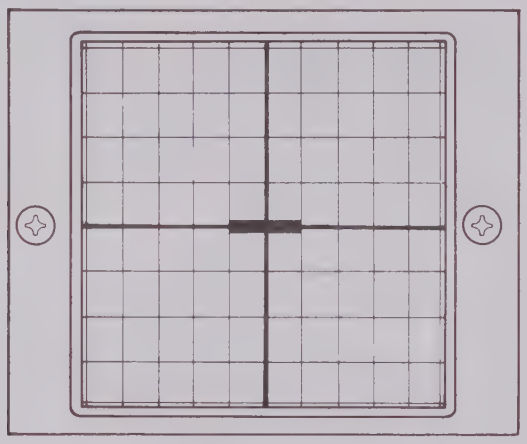


FIGURE 4-64 HORIZONTAL TRACE ALIGNED WITH MAJOR HORIZONTAL AXIS (USING POSITIVE AND NEGATIVE DETECTOR)

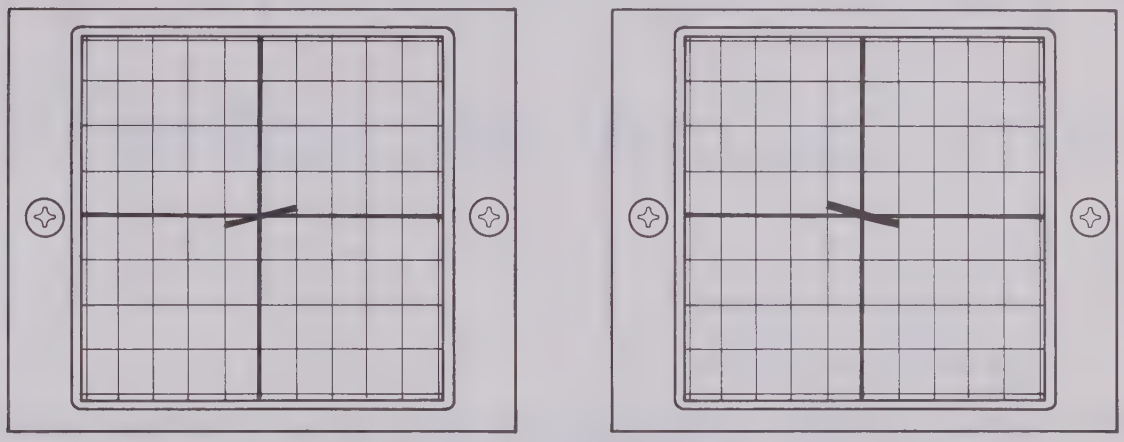
11. Rotate RF LEVEL/BFO INJECTION Dial (5) cw to add 3 dB to signal strength. The major horizontal axis now represents the -3 dB point (or half power point) of CUT.

NOTE

- If the 3 dB point above major horizontal (below axis when using negative detector) cannot be achieved because of significant attenuation, repeat Step 10 until horizontal trace is aligned with any other horizontal graticule marking above or below major horizontal axis. After repeating Step 11, selected horizontal marking will represent the -3 dB point (or half power point) of frequency response curve.

STEP PROCEDURE

12. Increment FREQUENCY MHz Thumbwheels (32) until horizontal trace is centered at point where major vertical and horizontal axes intersect. Record setting of FREQUENCY MHz Thumbwheels (32).



USING POSITIVE DETECTOR USING NEGATIVE DETECTOR

FIGURE 4-65 HORIZONTAL TRACE (OR SECTION OF FREQUENCY RESPONSE CURVE) POSITIONED AT INTERSECTION OF MAJOR AXES

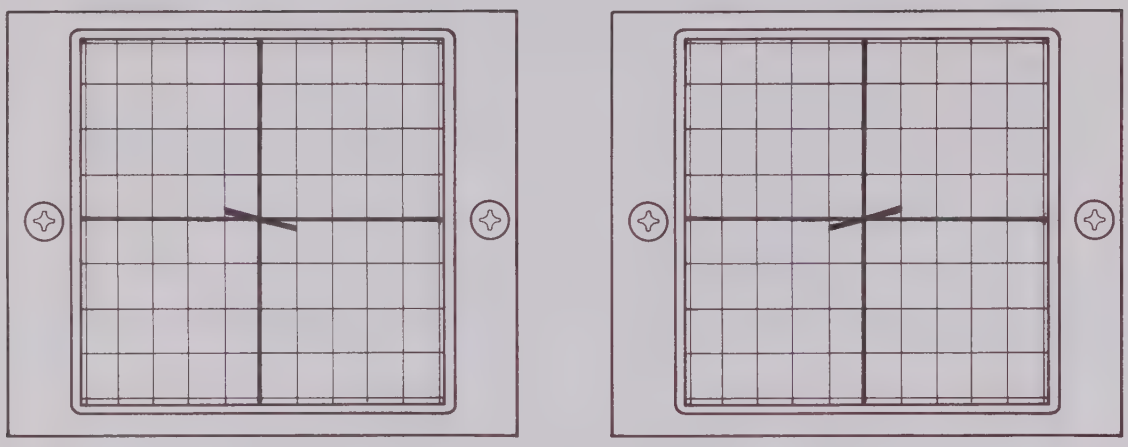
13. Decrement FREQUENCY MHz Thumbwheels (32) until horizontal trace is centered at point where major vertical and horizontal axes intersect. Record setting of FREQUENCY MHz Thumbwheels (32).

NOTE

- While preforming Step 13, horizontal trace will deviate from intersection of major vertical and horizontal axes before returning to its centered position as shown in Figure 4-66 on following page.

STEP PROCEDURE

13. (cont'd)



USING POSITIVE DETECTOR USING NEGITIVE DETECTOR

FIGURE 4-66 HORIZONTAL TRACE (OR SECTION OF FREQUENCY RESPONSE CURVE) POSITIONED AT INTERSECTION OF MAJOR AXIS

14. To determine bandpass of CUT, subtract result of Step 13 from result of Step 12; difference represents bandpass of CUT.

15. To obtain center frequency of CUT, add result of Step 12 to result of Step 13 and divide total by two; quotient represents center frequency of CUT.

TEST PROCEDURE: ***MEASURING BANDPASS AND CENTER FREQUENCY OF AN IF STRIP (AM/FM RCVR)***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: Same as required for procedure 4-7-3, titled "USING THE FM/AM-1000S/A AS A SWEEP GENERATOR/TRACKING OSCILLOSCOPE", on page 4-81.

TEST SET-UP DIAGRAM: Use block diagrams below to locate injection and sample points within a typical UUT.

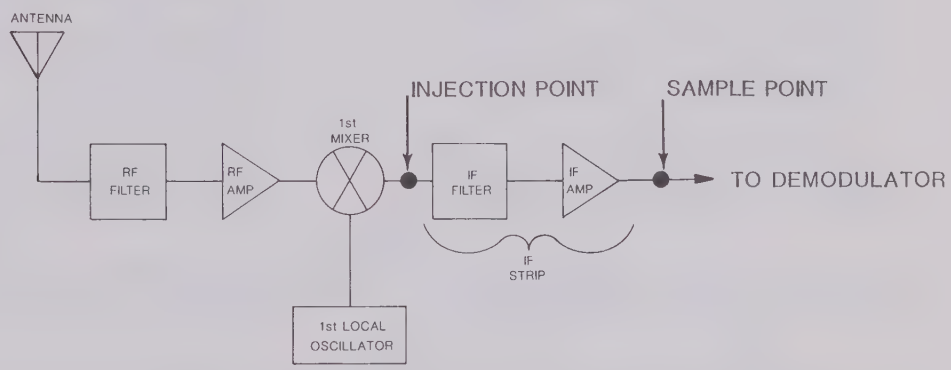


FIGURE 4-67 UUT SAMPLE AND INJECTION POINTS (SINGLE CONVERSION RECEIVER)

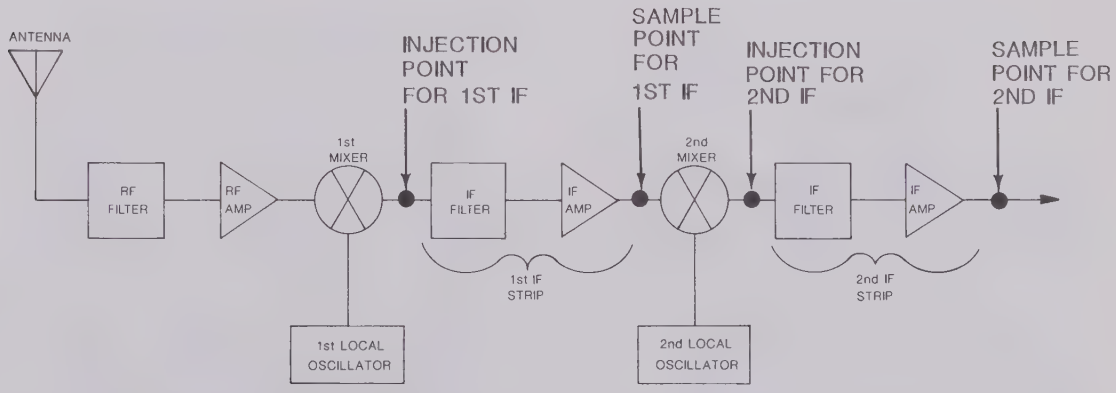


FIGURE 4-68 UUT SAMPLE AND INJECTION POINTS (DUAL CONVERSION RECEIVER)

STEP	PROCEDURE

1. Perform procedure 4-7-4, titled "MEASURING BANDPASS AND CENTER FREQUENCY OF A BANDPASS CIRCUIT", on page 4-87.

NOTE

- The circuit under test (CUT) referenced in above procedure is now represented by block diagrams furnished above.
- Center frequency of span to be swept will be IF frequency of UUT.

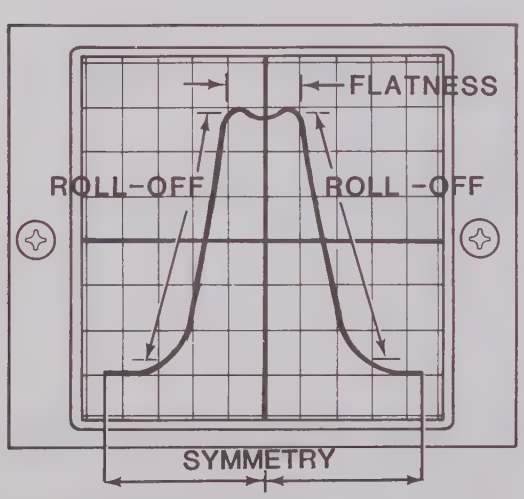
2. Return DEV/PWR Control (47) to "20 kHz" position.

3. Rotate INT MOD Control (23) cw until DEVIATION/WATTS Meter (1) reads 20 kHz.

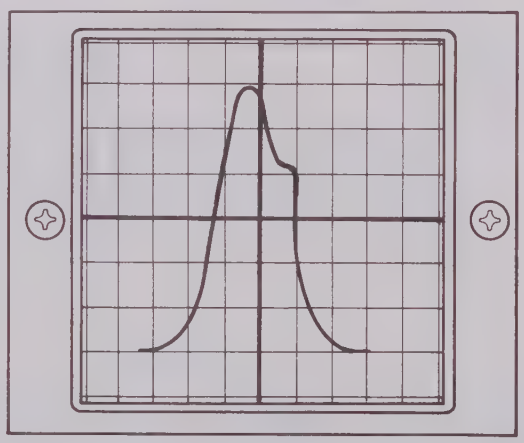
4. Observe frequency response curve for good flatness, symmetry and roll-off characteristics.

NOTE

- Examples below reflect measurements taken with a positive detector.
- Narrow bandwidth receivers will not exhibit flatness characteristic.



FREQUENCY RESPONSE CURVE CHARACTERISTICS

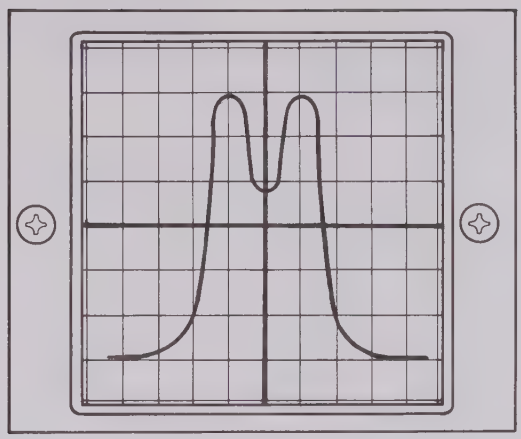


NON - SYMMETRICAL FREQUENCY RESPONSE CURVE WITH POOR FLATNESS

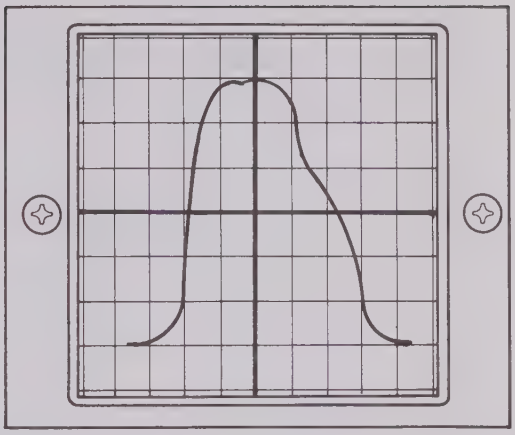
FIGURE 4-69 TYPICAL DISPLAYS OF FREQUENCY RESPONSE CURVE

STEP PROCEDURE

4. (cont'd)



SYMMETRICAL FREQUENCY RESPONSE CURVE LACKING FLATNESS



NON-SYMMETRICAL FREQUENCY CURVE WITH POOR ROLL-OFF.

FIGURE 4-70 TYPICAL DISPLAYS OF FREQUENCY RESPONSE CURVES

4-8-5

TEST PROCEDURE: ***MEASURING RECEIVER BANDPASS AND CENTER FREQUENCY (FOR BANDPASSES LESS THAN 40 kHz)***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: Same as required for procedure 4-7-3, titled "USING THE FM/AM-1000S/A AS A SWEEP GENERATOR/ TRACKING OSCILLOSCOPE", on page 4-81.

TEST SET-UP DIAGRAM: Use block diagrams below to locate injection and sample points within a typical UUT.

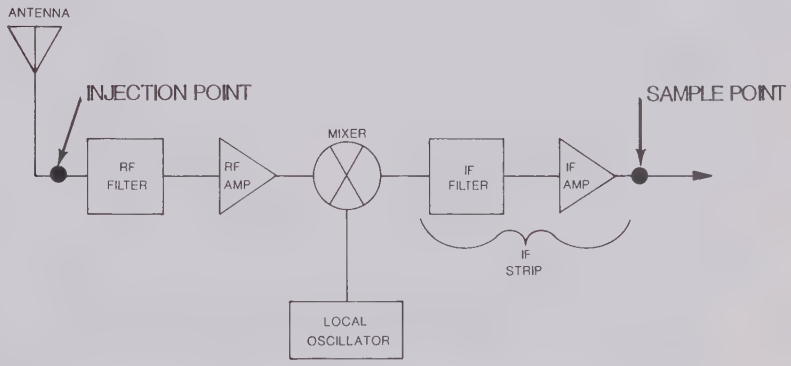


FIGURE 4-71 UUT INJECTION AND SAMPLE POINTS (SINGLE CONVERSION RECEIVER)

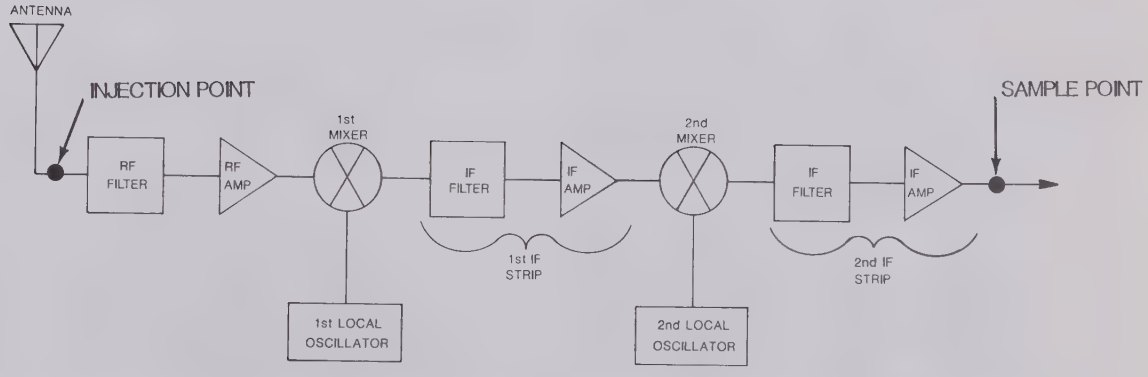


FIGURE 4-72 UUT INJECTION AND SAMPLE POINTS (DUAL CONVERSION RECEIVER)

STEP	PROCEDURE

1. Perform procedure titled 4-7-4, "MEASURING CENTER FREQUENCY AND BANDPASS OF A BANDPASS CIRCUIT", on page 4-87.

NOTE

- The circuit under test (CUT) referenced in above procedure is now represented by block diagrams furnished above.
- Center frequency of span to be swept will be receiver frequency.

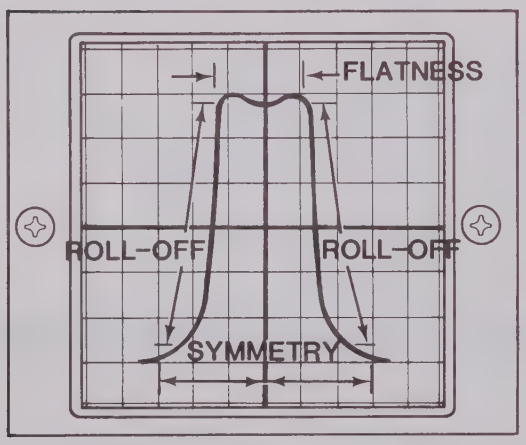
2. Return DEV/PWR Control (47) to "20 kHz" position.

3. Rotate INT MOD Control (23) cw until DEVIATION/WATTS Meter reads "20 kHz."

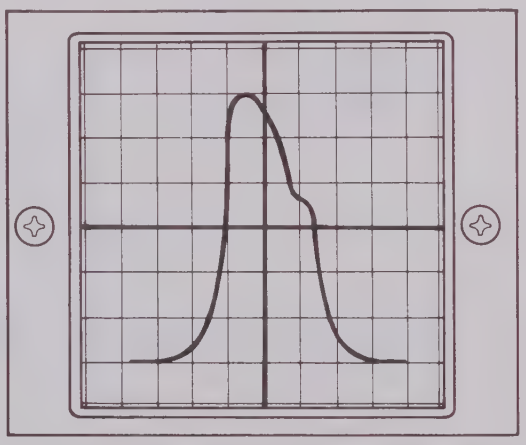
4. Observe bandpass response curve for good flatness, symmetry and roll-off charcteristics:

NOTE

- If frequency of UUT local oscillator is greater than sweep frequency (low side injection), the polarity of CRT display will be reversed; therefore, frequency is minimum on left side of CRT and maximum on right side of CRT.
- Examples below reflect measurements taken with a positive detector.
- Narrow bandwidth receivers will not exhibit flatness characteristic.



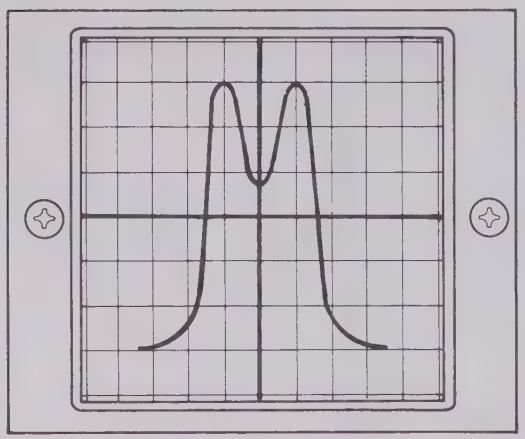
FREQUENCY RESPONSE CHARACTERISTICS



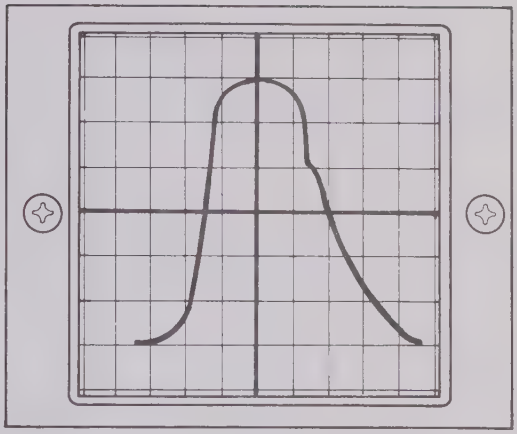
NON-SYMMETRICAL BANDPASS RESPONSE CURVE WITH POOR FLATNESS

FIGURE 4-73 TYPICAL DISPLAYS OF FREQUENCY RESPONSE CURVES FOR AVERAGE BAND RECEIVERS

4. (cont'd)

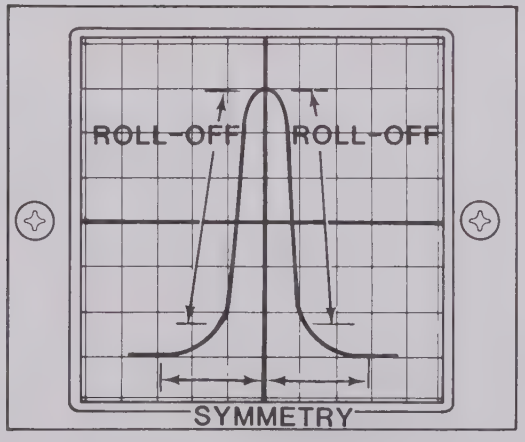


SYMMETRICAL BANDPASS RESPONSE CURVE LACKING FLATNESS

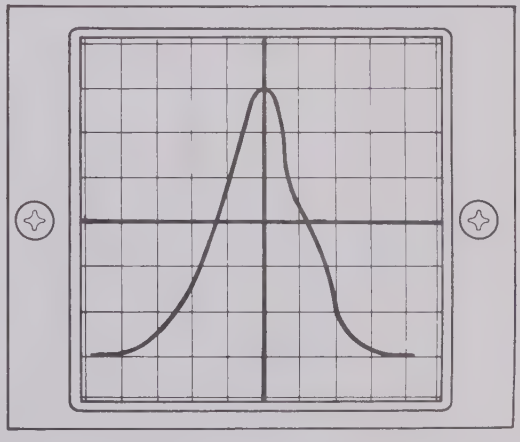


NON-SYMMETRICAL BANDPASS RESPONSE CURVE WITH POOR ROLL-OFF

FIGURE 4-74 TYPICAL DISPLAYS OF FREQUENCY RESPONSE CURVES FOR AVERAGE BAND RECEIVERS



FREQUENCY RESPONSE CURVE CHARACTERISTICS

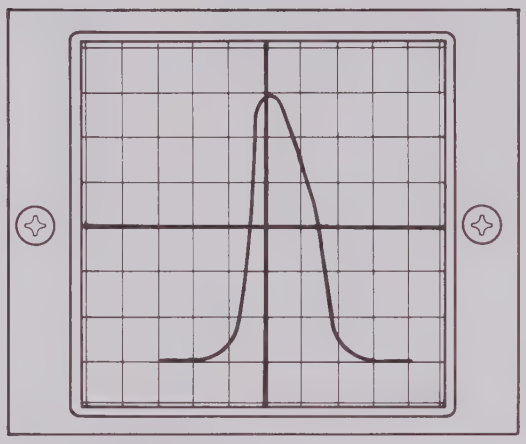


BANDPASS RESPONSE CURVE WITH POOR ROLL-OFF

FIGURE 4-75 TYPICAL DISPLAYS OF FREQUENCY RESPONSE CURVES FOR NARROW BAND RECEIVERS

STEP PROCEDURE

4. (cont'd)



BANDPASS RESPONSE CURVE
WITH POOR SYMMETRY

FIGURE 4-76 TYPICAL DISPLAY OF FREQUENCY RESPONSE CURVE FOR NARROW BAND RECEIVERS

TEST PROCEDURE: ***MEASURING RECEIVER BANDPASS AND CENTER FREQUENCY (FOR BANDPASSES GREATER THAN 40 kHz)***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: Same as required for procedure 4-7-3, titled "USING FM/AM-1000S/A AS A SWEEP GENERATOR/TRACKING OSCILLOSCOPE", on page 4-81.

TEST SET-UP DIAGRAM: Use block diagrams below to locate injection and sample points within a typical UUT.

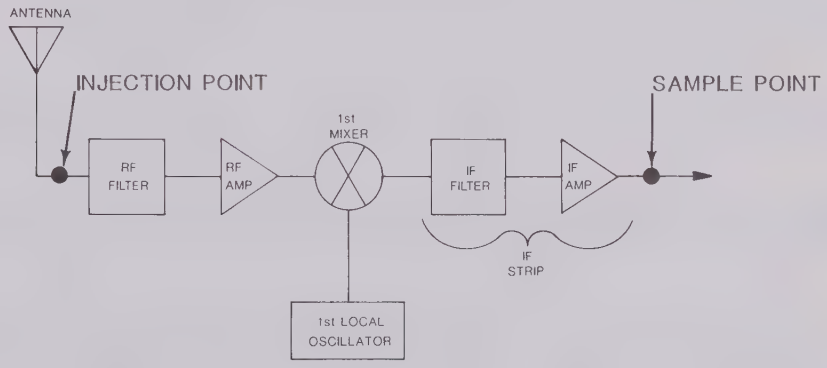


FIGURE 4-77 UUT INJECTION AND SAMPLE POINTS (SINGLE CONVERSION RECEIVER)

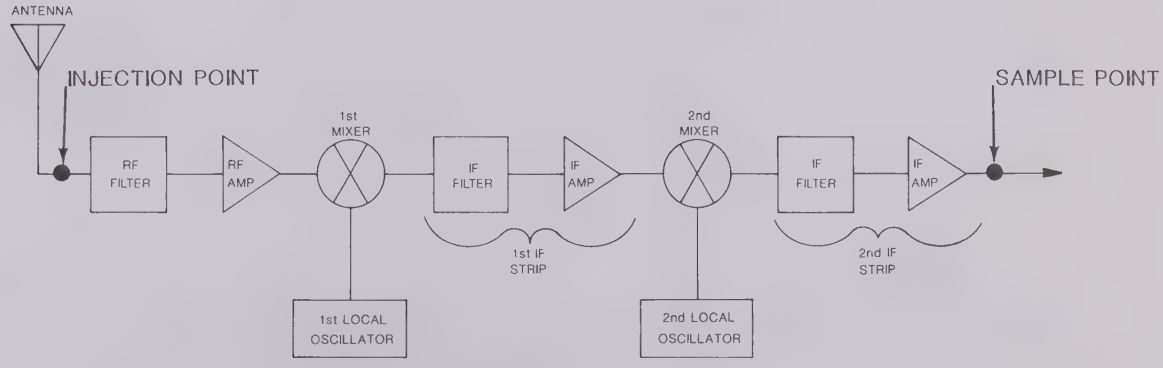


FIGURE 4-78 UUT INJECTION AND SAMPLE POINTS (DUAL CONVERSION RECEIVER)

STEP	PROCEDURE
1.	Perform Steps 1 through 9 of procedure 4-7-3, titled "USING FM/AM-1000S/A AS A SWEEP GENERATOR/TRACKING OSCILLOSCOPE", on page 4-81.
2.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw until horizontal trace is aligned with major horizontal axis.

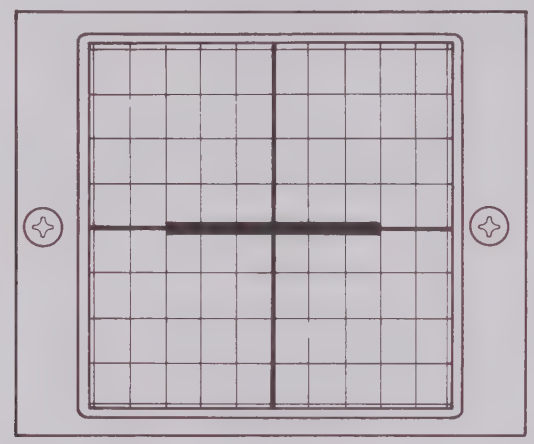


FIGURE 4-79 HORIZONTAL TRACE ALIGNED WITH MAJOR HORIZONTAL AXIS

3.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw to add 3 dB to signal strength. Oscilloscope is now displaying a small section of frequency response curve of UUT. The major horizontal axis on CRT now represents -3 dB point (or half power point of UUT.

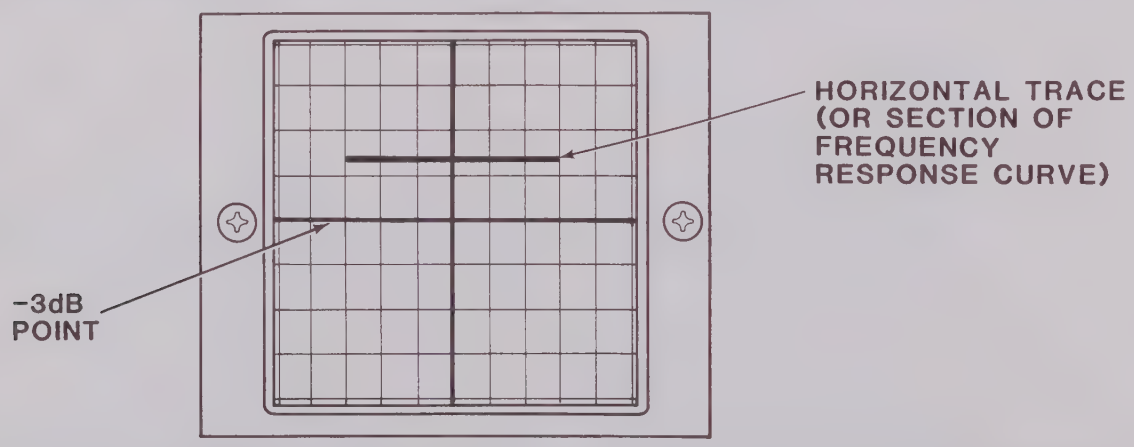


FIGURE 4-80 SECTION OF FREQUENCY RESPONSE CURVE DISPLAYED USING POSITIVE DETECTOR

STEP PROCEDURE

3. (cont'd)

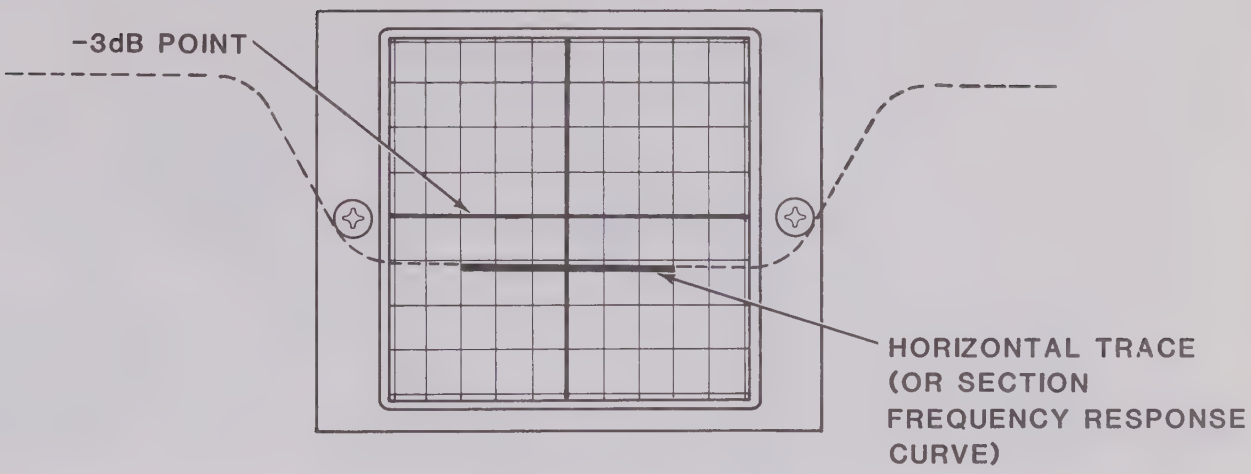


FIGURE 4-81 SECTION FREQUENCY RESPONSE CURVE DISPLAYED USING NEGATIVE DETECTOR

4. Increment FREQUENCY MHz Thumbwheels (32) to center high edge of frequency response curve at intersection of major vertical and horizontal axes.

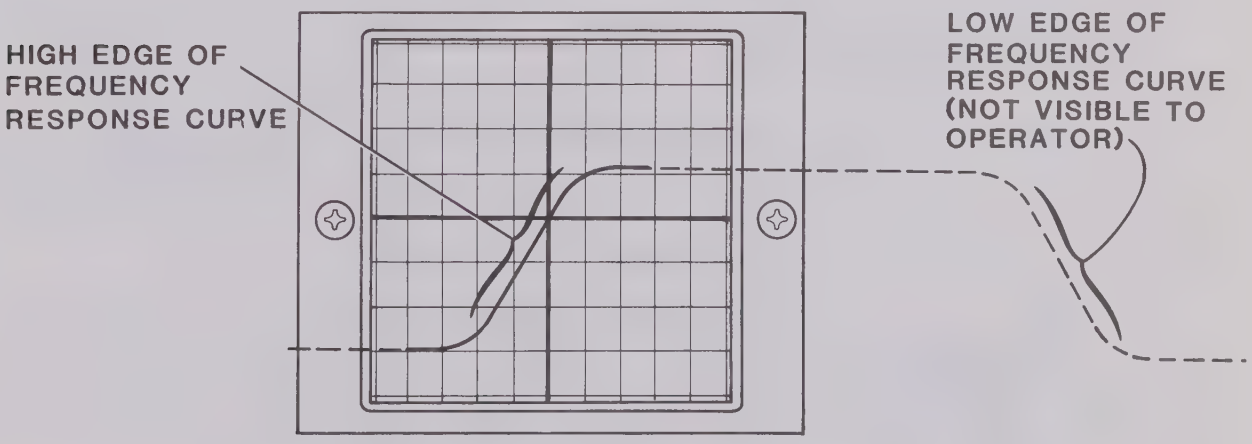


FIGURE 4-82 HIGH EDGE OF FREQUENCY RESPONSE CURVE CENTERED AT INTERSECTION OF MAJOR VERTICAL AND HORIZONTAL AXES (USING POSITIVE DETECTOR)

STEP PROCEDURE

4. (cont'd)

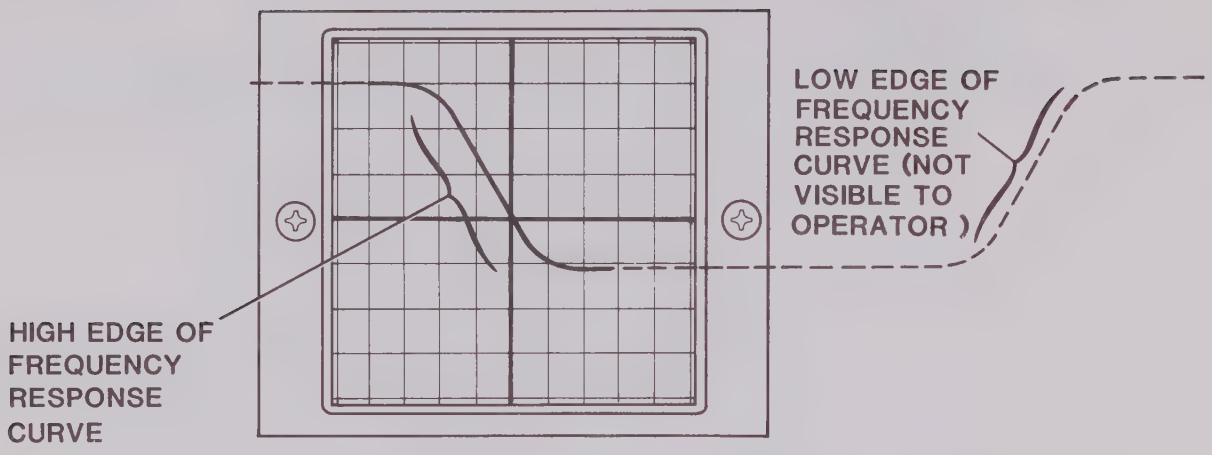


FIGURE 4-83 HIGH EDGE OF FREQUENCY RESPONSE CURVE CENTERED AT INTERSECTION OF MAJOR VERTICAL AND HORIZONTAL AXIS (USING NEGATIVE DETECTOR)

5. Record setting of FREQUENCY MHz Thumbwheels (32).

6. Decrement FREQUENCY MHz Thumbwheels (32) to center low edge of frequency response curve at intersection of major vertical and horizontal axes.

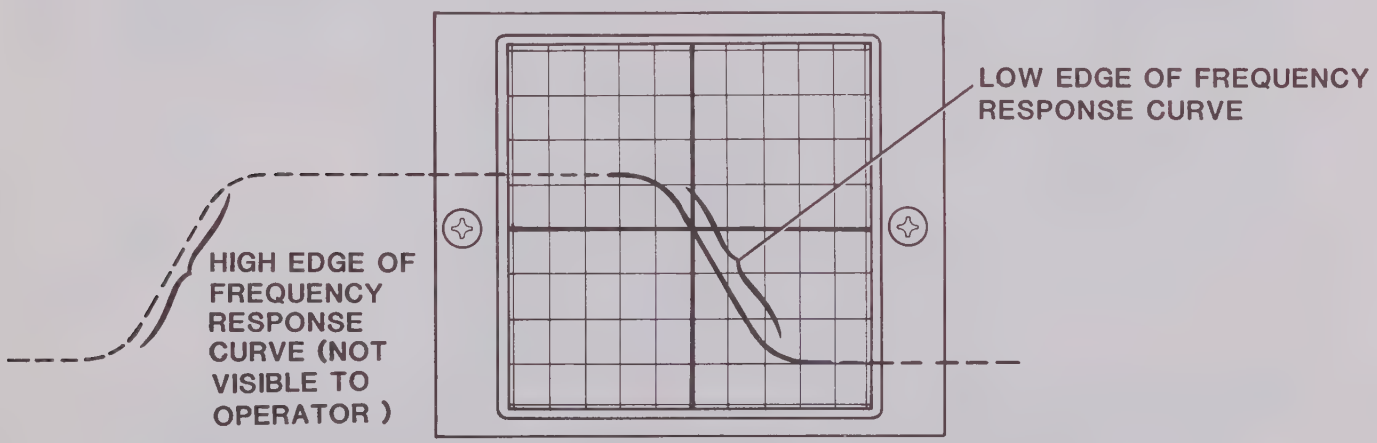


FIGURE 4-84 LOW EDGE OF FREQUENCY RESPONSE CURVE CENTERED AT INTERSECTION OF MAJOR VERTICAL AND HORIZONTAL AXIS (USING POSITIVE DETECTOR)

STEP PROCEDURE

6. (cont'd)

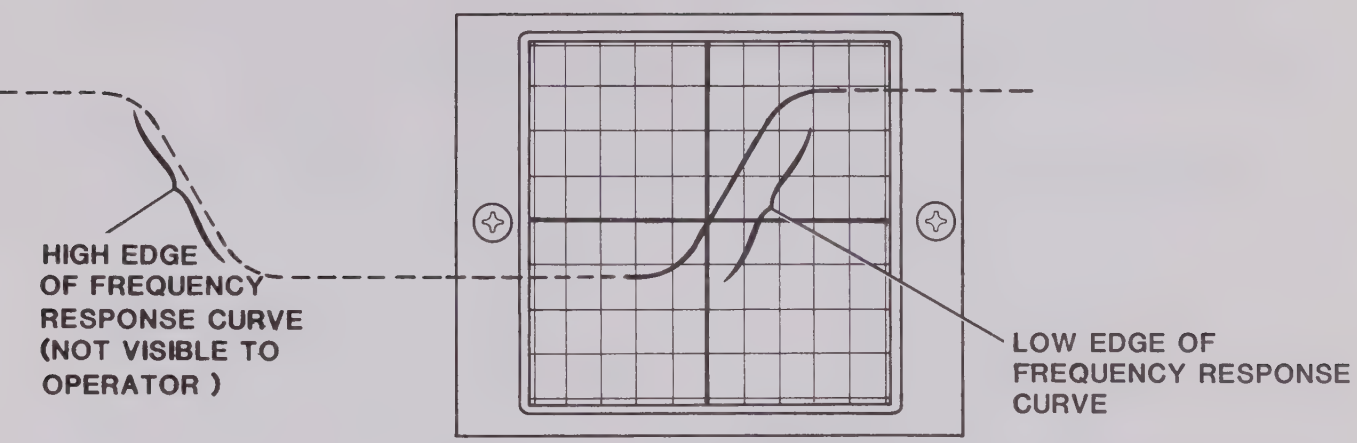


FIGURE 4-85 LOW EDGE OF FREQUENCY RESPONSE CURVE CENTERED AT INTERSECTION OF MAJOR VERTICAL AND HORIZONTAL AXIS (USING NEGATIVE DETECTOR)

7. Record present setting of FREQUENCY MHz Thumbwheels (32).

8. Subtract result obtained in Step 7 from result obtained in Step 5. Difference represents receiver bandpass.

9. To obtain bandpass center frequency, add result of Step 5 to result of Step 7 and divide total by two; quotient represents bandpass center frequency.

4-8-7

TEST PROCEDURE: ***MEASURING SQUELCH THRESHOLD AND DIFFERENTIAL (FOR AM/FM RECEIVERS WITH FIXED SQUELCH CONTROL)***

TEST OBJECTIVE: Using FM/AM-1000S/A as a signal generator to determine power level required to activate/deactivate UUT squelch. The level at which squelch is deactivated is "squelch threshold"; the difference between squelch threshold and point at which squelch is activated is the "squelch differential."

SPECIAL ACCESSORY EQUIPMENT REQ'D: 1 Coax cable with BNC male connector or one end and appropriate UUT connector on opposite end.

TEST SET-UP DIAGRAM:

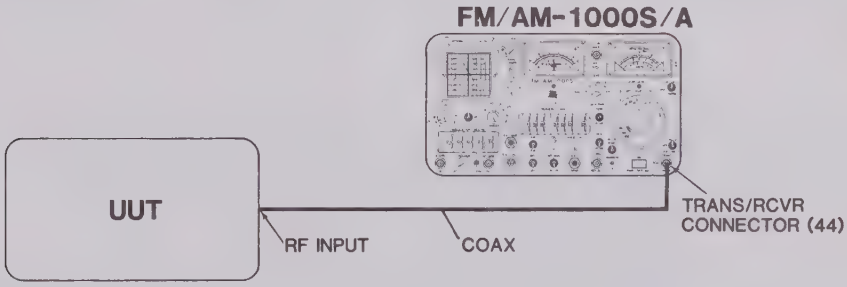


FIGURE 4-86 TEST SET-UP DIAGRAM FOR MEASURING SQUELCH THRESHOLD AND DIFFERENTIAL (FIXED SQUELCH)

STEP	PROCEDURE
1.	Perform test procedure 4-5-4 or 4-5-5, titled "GENERATING AM (or FM, whichever applicable) MODULATED SIGNALS", on pages 4-57 or 4-59.

NOTE

- RF LEVEL/BFO INJECTION Dial (5) setting in above procedure should be .05 μV.

2. Connect UUT to FM/AM-1000S/A using required accessory equipment as shown in test set-up diagram above.

STEP	PROCEDURE
3.	Apply power to UUT.
4.	Set UUT audio gain control to a midrange setting.
5.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw slowly, until UUT audio output just becomes audible. This point represents maximum squelch threshold in dBm.

NOTE

- If an audio tone is not heard before RF LEVEL/BFO INJECTION Dial (5) is fully cw, place HI LVL/µV X 100/NORM Switch (3) to "µV x 100" position and repeat Step 5.

6. Record setting of RF LEVEL/BFO INJECTION Dial (5) on dBm scale.

NOTE

- If HI LVL/µV X 100/NORM Switch (3) is in "µV x 100" position, mathematically add 40 dB to setting of RF LEVEL/BFO INJECTION Dial (5) on dBm scale to obtain true squelch threshold level.

7. Rotate RF LEVEL/BFO INJECTION Dial (5) ccw slowly until audio tone ceases. Record setting of RF LEVEL/BFO INJECTION Dial (5) on dBm scale.

NOTE

- If HI LVL/µV X 100/NORM Switch (3) is in "µV x 100" position, mathematically add 40 dB to setting of RF LEVEL/BFO INJECTION Dial (5) on dBm scale to obtain true output level.

8. Subtract result of Step 5 from result of Step 7 to obtain squelch differential.

EXAMPLE:

Result of Step 5: -42 dBm
Result of Step 7: -44 dBm

(-44 dBm) - (-42 dBM) =
-44 dBm + 42 dBm = 2 dB Squelch Differential

TEST PROCEDURE: ***MEASURING SQUELCH THRESHOLD AND DIFFERENTIAL (FOR AM/FM RECEIVERS WITH VARIABLE SQUELCH CONTROL)***

TEST OBJECTIVE: Using FM/AM-1000S/A as a signal generator to determine power level required to activate/deactivate UUT squelch. The level at which squelch is deactivated is "squelch threshold"; the difference between squelch threshold and point at which squelch is activated is the "squelch differential."

SPECIAL ACCESSORY EQUIPMENT REQ'D: 1 Coax cable with BNC male connector on one end and appropriate UUT connector on opposite end.

TEST SET-UP DIAGRAM:

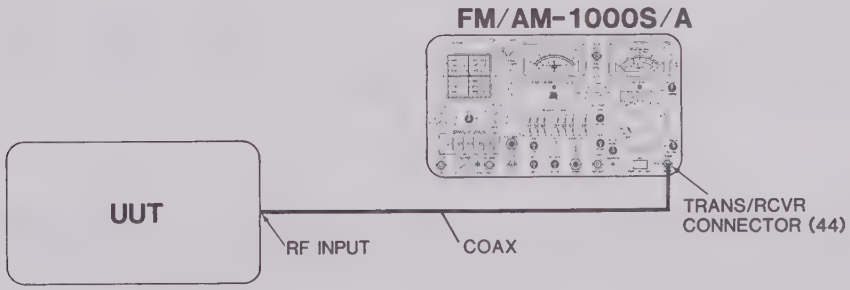


FIGURE 4-87 TEST SET-UP DIAGRAM FOR MEASURING SQUELCH THRESHOLD AND DIFFERENTIAL (VARIABLE SQUELCH)

STEP	PROCEDURE
1.	Perform test procedure 4-5-4 or 4-5-5, titled "GENERATING AM (or FM, whichever applicable) MODULATED SIGNALS", on pages 4-57 or 4-59.

NOTE

- RF LEVEL/BFO INJECTION Dial (5) setting in above procedure should be .05 µV.

2. Connect UUT to FM/AM-1000S/A using required accessory equipment as shown in test set-up diagram above.

STEP	PROCEDURE
3.	Apply power to UUT.
4.	Set UUT audio gain control to a midrange setting.
5.	Set UUT squelch control fully ccw (or "OFF" in detent if applicable).
6.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw slowly to confirm a gradual increase in the audio output of UUT.

NOTE

- This action is required to confirm that UUT squelch is disabled; audio tone should not become audible abruptly.

7.	Rotate RF LEVEL/BFO INJECTION Dial (5) fully ccw.
8.	Rotate UUT squelch control fully cw (Full "ON").
9.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw slowly until UUT audio output just becomes audible. This point represents maximum squelch threshold in dBm.

NOTE

- If an audio tone is not heard before RF LEVEL/BFO INJECTION Dial (5) is fully cw, place HI LVL/µV X 100/NORM Switch (3) to "µV x 100" position and repeat Step 9.

10.	Record setting of RF LEVEL/BFO INJECTION Dial (5) on dBm scale.

NOTE

- If HI LVL/µV X 100/NORM Switch (3) is in "µV x 100" position, mathematically add 40 dB to setting of RF LEVEL/BFO INJECTION Dial (5) on dBm scale to obtain true squelch threshold level.

11.	Rotate RF LEVEL/BFO INJECTION Dial (5) ccw slowly until audio tone ceases. Record setting of RF LEVEL/BFO INJECTION Dial (5) on dBm scale.

NOTE

- If HI LVL/µV X 100/NORM Switch (3) is in "µV x 100" position, mathematically add 40 dB to setting of RF LEVEL/BFO INJECTION Dial (5) on dBm scale to obtain true output level.

STEP	PROCEDURE
12.	Subtract result of Step 9 from result of Step 11 to obtain squelch differential.

EXAMPLE:

Result of Step 9: -42 dBm
Result of Step 11: -44 dBm

(-44 dBm) - (-42 dBM) =
-44 dBm + 42 dBm = 2 dB Squelch Differential

TEST PROCEDURE: ***MEASURING AGC ACTION (AM RCVR)***

TEST OBJECTIVE: Determining received signal strength at which receiver AGC circuit threshold is achieved.

NOTE

- This procedure is not valid for receivers with audio AGC in the output.

SPECIAL ACCESSORY EQUIPMENT REQ'D:

1 BNC "Tee" connector

1 "Dummy" load (to match impedance of UUT audio output)

2 Coax cables with BNC male connectors on one end and appropriate UUT connectors on opposite end.

TEST SET-UP DIAGRAM:

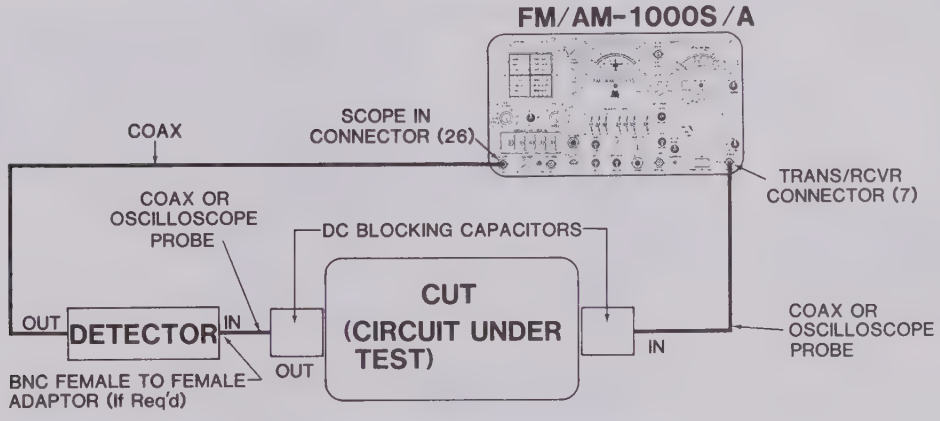


FIGURE 4-88 TEST SET-UP DIAGRAM FOR MEASURING AGC ACTION

STEP	PROCEDURE
1.	Perform procedure 4-5-3, titled "GENERATING RF SIGNALS", on page 4-55.

NOTE

- RF LEVEL/BFO INJECTION Dial (5) setting in above procedure should be .05 μV.

STEP	PROCEDURE
2.	Place AM/FM Switch (19) to "AM."
3.	Set MODULATION FREQ Hz Thumbwheels (25) to 1000.0 Hz.
4.	Rotate ANALY DISPR Control (39) fully ccw to detent position.
5.	Rotate EXT V/DIV Control (31) to "1.5 kHz", "6 kHz" or "15 kHz" position.
6.	Rotate EXT V/DIV Vernier Control (30) to "CAL" position.
7.	Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately for a sharp visible trace display.
8.	Adjust VERT Control (38) and HORIZ Control (36) to obtain a centered trace, with lower edge of displayed carrier signal aligned with major horizontal axis.

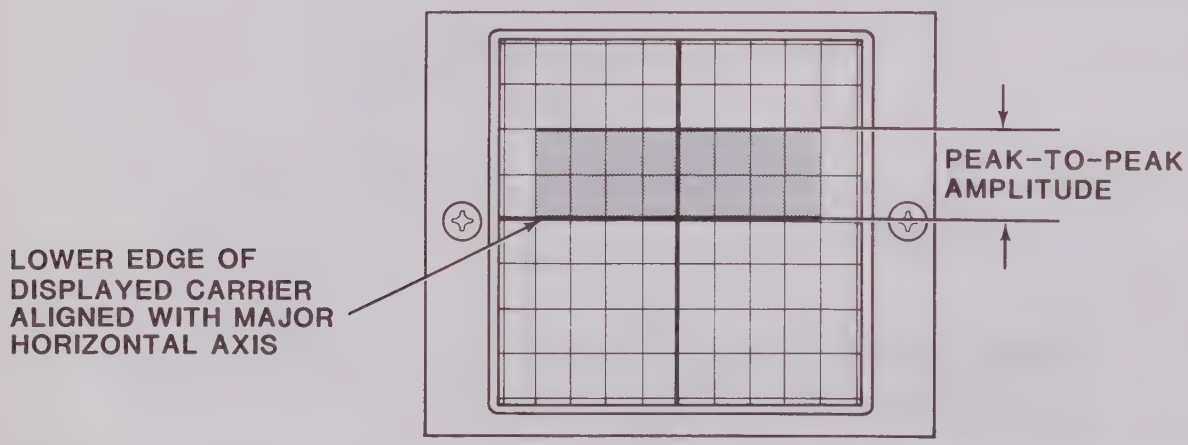


FIGURE 4-89 DISPLAYED CARRIER SIGNAL ALIGNED WITH MAJOR HORIZONTAL AXIS

9.	Measure peak-to-peak amplitude (in graticule division) of displayed carrier. Record result.
10.	Apply result obtained in Step 9 to following equation and record value of "x":

$$x = 0.3 \text{ (Result of Step 9)}$$

Where x = number of graticule divisions (peak-to-peak) of modulated signal

STEP	PROCEDURE

11. a. Adjust VERT Control (38) to align negative peak of one of the modulated signals with major horizontal axis.

b. Rotate INT MOD Control (23) to adjust peak-to-peak amplitude of same modulated signal (in graticule divisions) to value of "x" obtained in Step 10.

NOTE

- Steps 11a and 11b must be performed simultaneously, as both are interactive.

EXAMPLES:

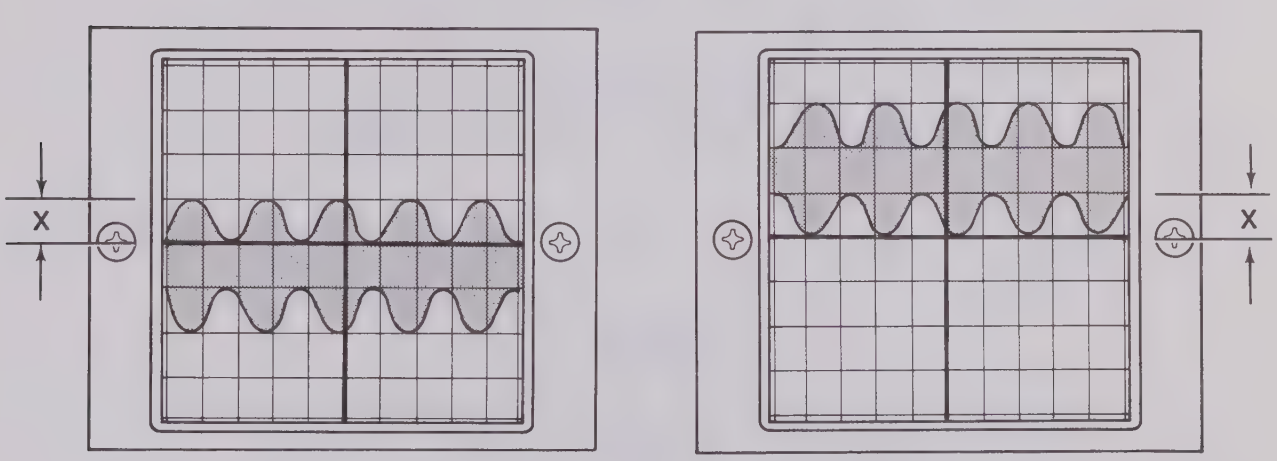


FIGURE 4-90 ALIGNMENT OF UPPER AND LOWER MODULATION SIGNALS WITH MAJOR HORIZONTAL AXIS

c. The FM/AM-1000S/A signal generator is now calibrated to 30% modulation and is generating at selected frequency and output level.

12. Connect UUT to FM/AM-1000S/A to UUT and required test equipment as shown in test set-up diagram above.

13. Apply power to UUT.

STEP	PROCEDURE
14.	Set UUT audio gain control to a midrange setting. Up to this point, FM/AM-1000S/A scope should display a modulated signal similar to that shown below.

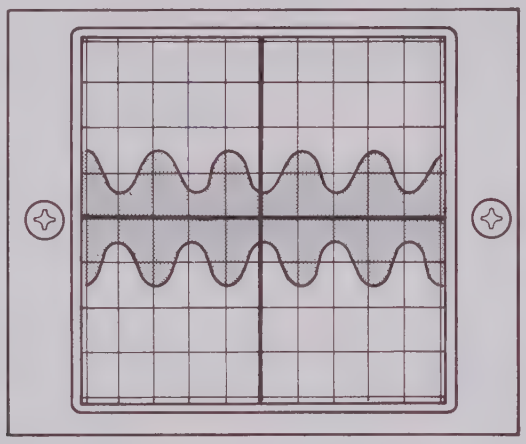


FIGURE 4-91 MODULATED SIGNAL DISPLAY

15. Rotate EXT V/DIV Control (31) to "10 volts/division" position. Scope may display a horizontal trace containing a small level of noise.

NOTE

- If audio output rating of UUT is low power, EXT V/DIV Control (31) may require positioning to "1 or .1 volts/division" setting.

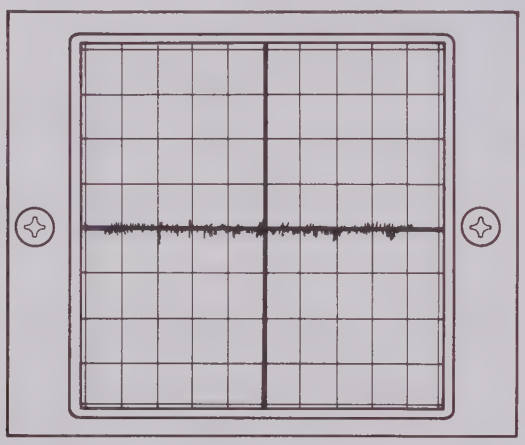


FIGURE 4-92 SCOPE TRACE EXHIBITING MINOR AMOUNT OF NOISE

STEP	PROCEDURE
16.	Slowly rotate RF LEVEL/BFO INJECTION Dial (5) cw while observing scope display; the following progression will be evident with respect to horizontal trace on CRT:

a. While rotating RF LEVEL/BFO INJECTION Dial (5) cw, noise on horizontal trace will continuously change in amplitude, ultimately developing into a sine wave.

b. The sine wave will increase in amplitude proportionately to the cw rotation of RF LEVEL/BFO INJECTION Dial (5).

c. During rotation of the RF LEVEL/BFO INJECTION Dial (5), a point will be reached where sine wave no longer increases in amplitude (or increases very little). Position RF LEVEL/BFO INJECTION Dial (5) to the point where this transition occurs.

d. Read setting of RF LEVEL/BFO INJECTION Dial (5) on dBm scale. This setting represents the "AGC threshold" of the UUT.

NOTE

- If the AGC threshold in not reached when RF LEVEL/BFO INJECTION Dial (5) is fully cw, place HI LVL/µV X 100/NORM Switch (3) to "µV x 100" position and repeat Step 6. An additional 40 dB must now be mathematically added to reading obtained in Step 6d to obtain true AGC threshold.

4-8-10

TEST PROCEDURE: ***MEASURING RECEIVER SENSITIVITY (AM RCVR)***

TEST OBJECTIVE: Determining carrier strength required to produce a 10 dB difference in receiver audio output between an unmodulated carrier and same carrier modulated at 30% with a 1 kHz tone.

SPECIAL ACCESSORY EQUIPMENT REQ'D: AC Voltmeter

TEST SET-UP DIAGRAM:

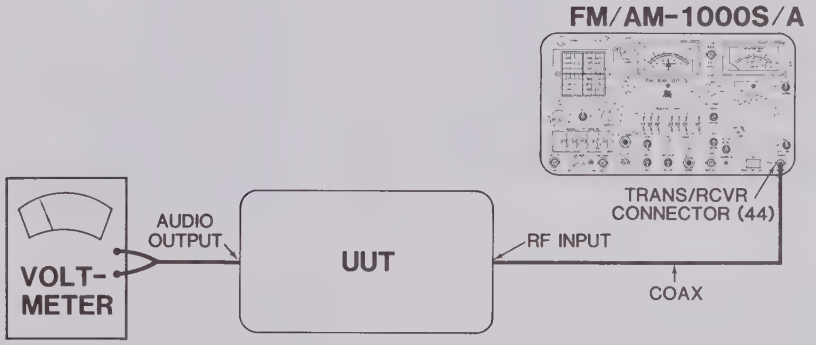


FIGURE 4-93 TEST SET-UP DIAGRAM FOR MEASURING AM SENSITIVITY

STEP	PROCEDURE
1.	Perform procedure 4-5-3, titled "GENERATING RF SIGNALS", on page 4-55.
2.	Place AM/FM Switch (19) to "AM."
3.	Set MODULATION FREQ Hz Thumbwheels (25) to 1000.0 Hz.
4.	Rotate ANALY DISPR Control (39) fully ccw to detent position.
5.	Rotate EXT V/DIV Control (31) to "1.5 kHz", "6 kHz" or "15 kHz" position.
6.	Rotate EXT V/DIV Vernier Control (30) to "CAL" position.
7.	Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately for a sharp visible trace display.

STEP	PROCEDURE
8.	Adjust VERT Control (38) and HORIZ Control (36) to obtain a centered trace, with lower edge of displayed carrier aligned with major horizontal axis.

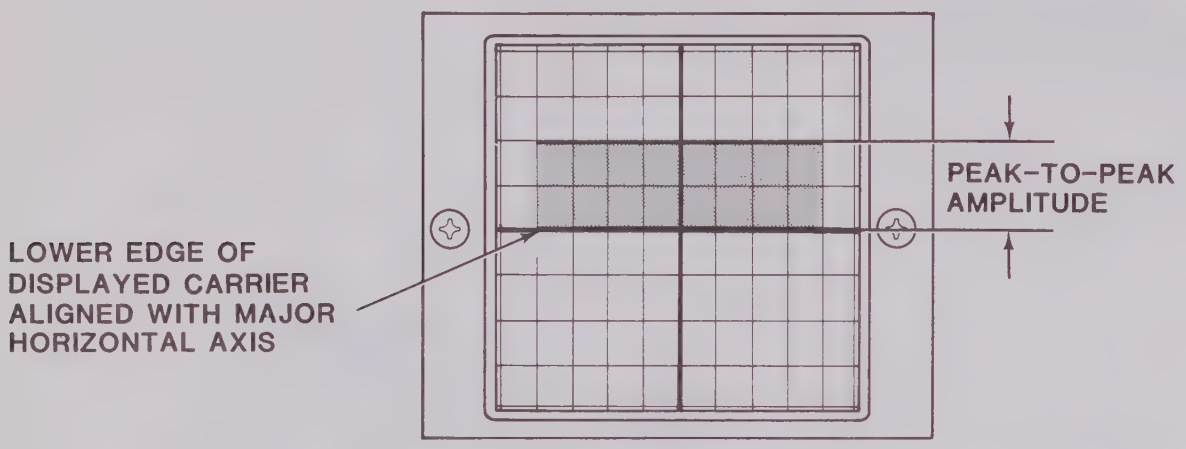


FIGURE 4-94 DISPLAYED CARRIER SIGNAL ALIGNED WITH MAJOR HORIZONTAL AXIS

9. Measure peak-to-peak amplitude (in graticule divisions) of displayed carrier. Record result.

10. Apply result obtained in Step 9 to following equation and record value of "x":

$$x = 0.3 \text{ (Result of Step 9)}$$

where x = number of graticule divisions (peak-to-peak) of modulated signal

11. a. Adjust VERT Control (38) to align negative peak of one of the modulated signals with major horizontal axis.

b. Rotate INT MOD Control (23) to adjust peak-to-peak amplitude of same modulated signal (in graticule divisions) to value of "x" obtained in Step 10.

NOTE

- Steps 11a and 11b must be performed simultaneously, as both are interactive.

STEP PROCEDURE

11. (cont'd)

EXAMPLES:

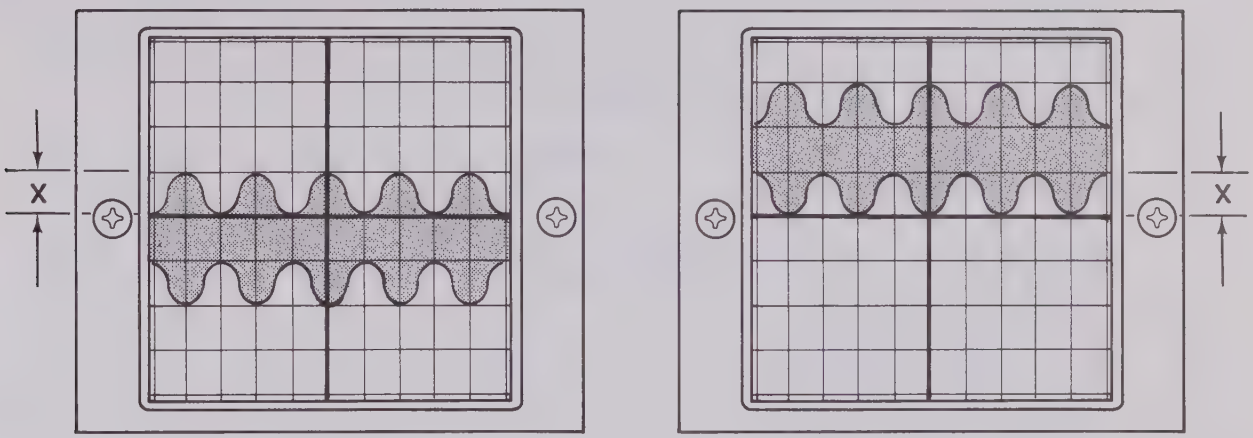


FIGURE 4-95 ALIGNMENT OF UPPER AND LOWER MODULATION SIGNALS WITH MAJOR HORIZONTAL AXIS

c. The FM/AM-1000S/A signal generator is now calibrated to 30% modulation and is generating at selected frequency and output level.

12. Connect FM/AM-1000S/A to UUT and required accessory equipment as shown in Test Set-Up Diagram above.

13. Rotate RF LEVEL/BFO INJECTION Dial (5) cw until FM/AM-1000S/A is generating sufficient RF to quiet UUT.

14. Adjust UUT audio gain control to achieve maximum rated audio output power. Note value obtained on voltmeter.

15. Rotate INT MOD Control (23) fully ccw to detent (OFF) position (0% modulation).

16. Rotate RF LEVEL/BFO INJECTION Dial (5) appropriately until voltmeter displays a noise level 10 dB below level obtained in Step 14.

17. Rotate INT MOD Control (23) cw until modulated signal is again at 30% modulation. (Reference value of "x" obtained in Step 10.)

STEP	PROCEDURE
18.	Check voltmeter reading; if voltmeter reading is equal to reading obtained in Step 14, setting of RF LEVEL/BFO INJECTION Dial (5) represents sensitivity of UUT (in µV or dBm). If voltmeter reading in this step does not equal reading obtained in Step 14, proceed with remaining steps below.
19.	Record present voltmeter reading.
20.	Rotate INT MOD Control (23) fully ccw to detent (OFF) position (0% modulation).
21.	Rotate RF LEVEL/BFO INJECTION Dial (5) appropriately until voltmeter displays a noise level 10 dB below level obtained in Step 19.
22.	Rotate IND MOD Control (23) cw until modulated signal is again at 30% modulation. (Reference value of "x" obtained in Step 10.)
23.	Check voltmeter reading; if voltmeter reading is equal to reading obtained in Step 19, setting of RF LEVEL/BFO INJECTION Dial (5) represents sensitivity of UUT (in µV or dBm). If voltmeter reading does not equal result obtained in Step 19, repeat Steps 19 thru 23 until result of Step 21 is 10 dB below result of Step 23.

4-8-11

TEST PROCEDURE: ***MEASURING 20 dB QUIETING (FM RCVR)***

TEST OBJECTIVE: To measure smallest discernable signal receiver under test is capable of receiving at a given noise level.

SPECIAL ACCESSORY EQUIPMENT REQ'D: 1 Coax cable with BNC male connector on one end and appropriate UUT connector on opposite end.

AC Voltmeter

TEST SET-UP DIAGRAM:

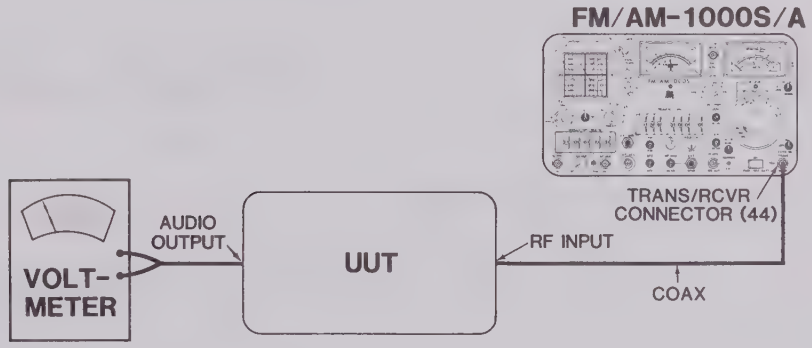


FIGURE 4-96 TEST SET-UP DIAGRAM FOR MEASURING FM RECEIVER 20 dB QUIETING

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for RF generator operation as shown in Figure 4-25, page 4-53.
2.	Set FREQUENCY MHz Thumbwheels (32) to frequency of UUT.
3.	Connect BNC male connector on end of coax cable to TRANS/RCVR Connector (7) on FM/AM-1000S/A.

STEP	PROCEDURE

3. (cont'd)

CAUTION

- DO NOT APPLY MORE THAN 20 WATTS OF CONTINUOUS INPUT TO THIS CONNECTOR. Maximum "ON" time for measurement of transmitter output using this connector is:

  10 seconds at 100 W, 15% Duty Cycle
  20 seconds at 50 W, 30% Duty Cycle
  2 minutes at 30 W, 50% Duty Cycle

4. Connect opposite end of coax cable to RF input of UUT.

5. Connect AC voltmeter across audio output terminals of UUT.

6. Apply power to UUT.

7. Apply power to FM/AM-1000S/A.

8. Adjust UUT audio output to obtain convenient reference output level on voltmeter (preferably on an even division marking of voltmeter scale).

9. Rotate RF LEVEL/BFO INJECTION Dial (5) cw until voltmeter reading decreases to one-tenth (1/10) of original reference reading.

NOTE

- If it is not possible to obtain one-tenth (1/10) voltage reading of reference level, place HI LVL/ µV X 100/NORM Switch (3) to "µV x 100" position.

10. Read UUT sensitivity on "dBm" scale of RF LEVEL/BFO INJECTION Dial (5).

NOTE

- If HI LVL/µV X 100/NORM Switch (3) is in the "µV x 100" position, mathematically add +40 dB to dBm reading of RF LEVEL/BFO INJECTION Dial (5) to obtain true sensitivity level.

EXAMPLE:

If result of Step 10 is -110 dBm, add +40 dB to this figure to obtain -60 dBm.

TEST PROCEDURE: ***MEASURING 12 dB SINAD SENSITIVITY (FM RCVR)***

TEST OBJECTIVE: To measure the amount of input signal a receiver requires to produce an output 12 dB above noise and distortion output levels. The 12 dB SINAD (SIgnal plus Noise And Distortion) figure provides an indication of input signal level required for understandable voice reception.

In this test, a tone modulated FM signal is applied to the RF input of receiver under test (UUT). The receiver's total audio output level is measured and compared against receivers noise/distortion level, while the RF input level is varied to obtain a 12 dB difference between the two levels.

SPECIAL ACCESSORY EQUIPMENT REQ'D:

Distortion Analyzer

Cables for connecting distortion analyzer to UUT.

1 Coax cable with BNC male connector on one end and appropriate UUT connector on opposite end.

TEST SET-UP DIAGRAM:

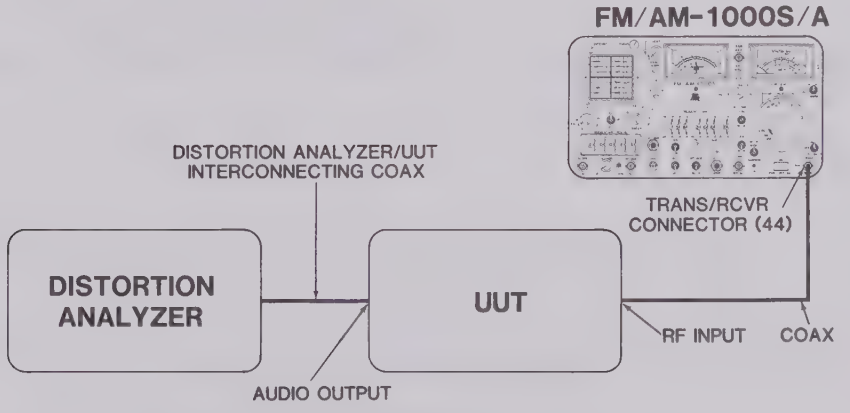


FIGURE 4-97 TEST SET-UP DIAGRAM FOR MEASURING 12dB SINAD SENSITIVITY

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for RF generator operation as shown in Figure 4-25, page 4-53.

STEP	PROCEDURE
2.	Make cable connections between FM/AM-1000S/A, UUT and distortion analyzer as shown in set-up diagram.
3.	Apply power to distortion analyzer.
4.	Apply power to UUT.
5.	Apply power to FM/AM-1000S/A.
6.	Set MODULATION FREQ Hz Thumbwheels (25) to 1000.0 Hz.
7.	Set FREQUENCY MHz Thumbwheels (32) to receiving frequency of UUT.
8.	Rotate INT MOD Control (23) cw so DEVIATION/WATTS Meter (1) reading is two-thirds (2/3) of UUT peak deviation.
9.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw until FM/AM-1000S/A is generating sufficient RF to quiet UUT.

NOTE

- If unable to quiet receiver in above step, place HI LVL/µV X 100/NORM Switch (3) to "µV x 100" position. Then rotate RF LEVEL/BFO INJECTION Dial (5) to a level sufficient to quiet receiver.

10.	Adjust UUT audio output to maximum rated power level (refer to UUT specifications).
11.	Adjust distortion analyzer to display a ratio of signal to distortion levels.
12.	Rotate RF LEVEL/BFO INJECTION Dial (5) ccw until distortion analyzer displays 12 dB SINAD or 25% distortion.

a. Present setting of RF LEVEL/BFO INJECTION Dial (5) represents 12 dB SINAD sensitivity of UUT.

NOTE

- If HI LVL/µV x 100/NORM Switch is in the "µV x 100" position, mathematically add +40 dB to dBm reading of RF/BFO INJECTION DIAL (5) to obtain true sensitivity level.

TEST PROCEDURE: ***MEASURING MAXIMUM RECEIVABLE DEVIATION (FM RCVR)***

TEST OBJECTIVE: To determine maximum acceptable FM deviation of UUT.

SPECIAL ACCESSORY EQUIPMENT REQ'D: See procedure titled "MEASURING 12 dB SINAD SENSITIVITY"

TEST SET-UP DIAGRAM: See procedure titled "MEASURING 12 dB SINAD SENSITIVITY"

STEP	PROCEDURE
1.	Perform procedure 4-8-12, titled "MEASURING 12 dB SINAD SENSITIVITY", on page 4-151.
2.	Rotate RF LEVEL/BFO INJECTION Dial (5) cw to increase dBm reading by 20 dB (or per UUT specifications).
3.	Rotate INT MOD Control (23) cw until distortion analyzer displays a distortion level 12 dB below signal level.
4.	Multiply reading of DEVIATION/WATTS Meter (1) by two. Result represents modulation acceptance bandwidth of UUT.

4-9 GENERAL TRANSMITTER TESTS

4-9-1 GENERAL

This section contains an assortment of the more common tests to be used in evaluating AM/FM transmitter performance using the FM/AM-1000S/A. The tests included were selected on the basis of appropriateness, wide ranging applicability and minimal support equipment required to complete the tests.

This test procedures contained in this section are:

4-9-2 MEASURING TRANSMITTER CARRIER POWER
4-9-3 MEASURING TRANSMITTER FREQUENCY
4-9-4 MEASURING AM MODULATION OF A TRANSMITTER
4-9-5 MEASURING TRANSMITTER DEVIATION (Below ±20 kHz)

TEST PROCEDURE: ***MEASURING TRANSMITTER CARRIER POWER***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: 1 Coax cable with BNC male connector on one end and appropriate UUT connector on opposite end.

TEST SET-UP DIAGRAM:

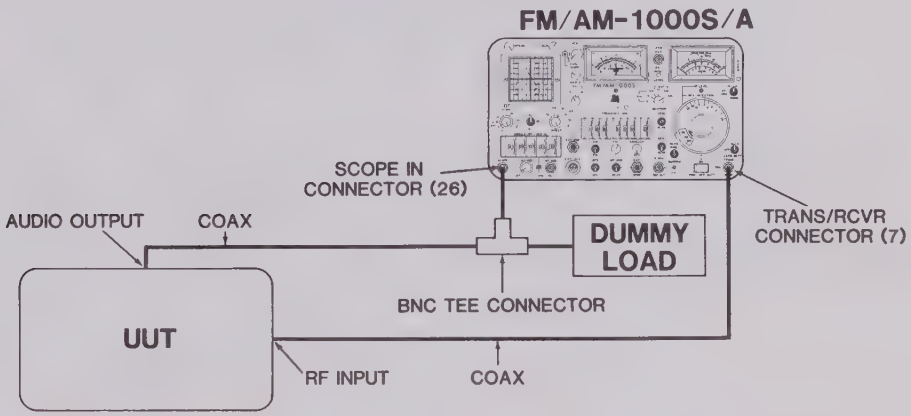


FIGURE 4-98 TEST SET-UP DIAGRAM FOR MEASURING TRANSMITTER CARRIER POWER

STEP	PROCEDURE
1.	Set FM/AM-1000S/A controls for receiver operation (AM or FM) as shown in Figure 4-28, page 4-63.
2.	Apply power to FM/AM-1000S/A.
3.	Apply power to UUT.
4.	Connect coax cable between UUT RF output and FM/AM-1000S/A TRANS/RCVR Connector (7), as shown in test set-up diagram above.
5.	Rotate DEV/PWR Control (47) to "WATTS x 10" position.

STEP	PROCEDURE
6.	Key up UUT. Read UUT power output on red scale of DEVIATION/ WATTS Meter (1).

NOTE

- If DEVIATION/WATTS Meter (1) needle deflection is less than 10 Watts when UUT is keyed, rotate DEV/PWR Control (46) to "WATTS x 1" position.

- On FM/AM-1000S models, UUT power output can also be viewed on spectrum analyzer dB scale, using following approximate equivalencies; (frequency MHz Thumbwheels must be set to frequency of UUT and ANALY DISPR Control (39) must be out of detent position):

  -30 dB marking on spectrum analyzer = 100 Watts
  -40 dB marking on spectrum analyzer = 10 Watts
  -50 dB marking on spectrum analyzer = 1 Watt
  -60 db marking on spectrum analyzer = .1 Watt

4-9-3

TEST PROCEDURE: ***MEASURING TRANSMITTER FREQUENCY (APPLICABLE TO FM/AM-1000S MODELS ONLY)***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: Same as for procedure titled "MEASURING TRANSMITTER CARRIER POWER"

TEST SET-UP DIAGRAM: Same as for procedure titled "MEASURING TRANSMITTER CARRIER POWER"

STEP	PROCEDURE
1.	Set FM/AM-1000S controls for receiver operation (AM or FM) as shown Figure 4-28, page 4-63.
2.	Set FM/AM-1000S controls for spectrum analyzer operation as shown in Figure 4-16, page 4-33.
3.	Connect coax cable between UUT output and FM/AM-1000S TRANS/ RCVR Connector (7) as shown in test set-up diagram above.
4.	Apply power to FM/AM-1000S.
5.	Apply power to UUT.
6.	Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately to obtain a sharp visible trace display.

NOTE

- Warm-up time of CRT is approximately 30 seconds from a "cold" start-up; trace display will not become visible until CRT achieves warm-up.

7.	Set FREQUENCY MHz Thumbwheels (32) to within ±5 MHz of UUT frequency.
8.	Key up UUT while observing spectrum analyzer. Locate UUT spectrum.
9.	Increment or decrement FREQUENCY MHz Thumbwheels (32) while continuously keying UUT, until spectrum of UUT is aligned with major vertical axis on CRT.
10.	Rotate ANALY DISPR Control (39) fully ccw short of detent position.
11.	Repeat Step 9.

STEP	PROCEDURE
12.	Rotate 1.5/5/15 kHz Control (33) to "5 kHz" position.
13.	Increment or decrement FREQUENCY MHz Thumbwheels (32) while continuously keying UUT, until FREQ ERROR Meter (41) reads zero.
14.	Rotate 1.5/5/15 kHz Control (33) to "1.5 kHz" position.
15.	Repeat Step 13.
16.	Add or subtract residual FREQ ERROR Meter (41) reading (less than 100 Hz) to or from setting of FREQUENCY MHz Thumbwheels (32). Result represents transmitting frequency.

TEST PROCEDURE: ***MEASURING AM MODULATION OF A TRANSMITTER***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D:

1 BNC "Tee" connector

2 Coax cables with BNC male connectors on one end and appropriate UUT connectors on opposite end.

1 Short coax cable with BNC male connector on each end.

1 DC blocking capacitor (required only if DC components are present)

TEST SET-UP DIAGRAM:

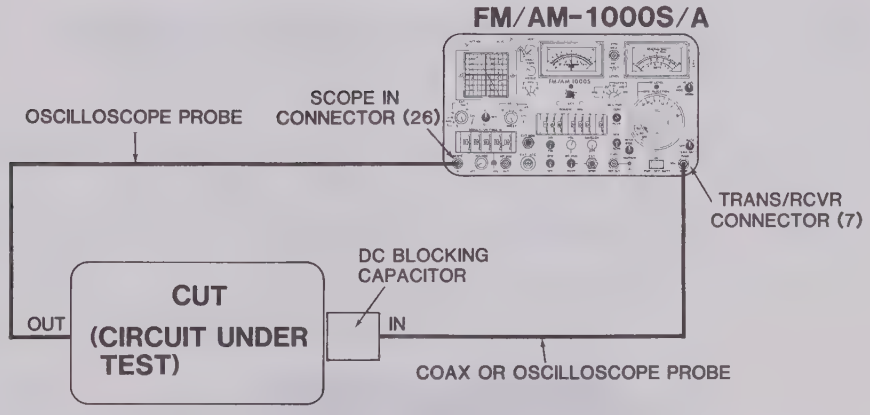


FIGURE 4-99 TEST SET-UP DIAGRAM FOR MEASURING AM MODULATION OF A TRANSMITTER

STEP	PROCEDURE
1.	Perform Steps 1 through 12 of procedure 4-4-3, titled "GENERATING AUDIO TONES OF KNOWN AMPLITUDE", on page 4-47. Frequency of audio tone to be generated is 1 kHz.

NOTE

- Amplitude of injected 1 kHz audio tone must be within limits of UUT input specifications.
- Tone injection point on UUT Is "Audio Input" or "Microphone Jack."

STEP	PROCEDURE
2.	Set FM/AM-1000S/A controls for AM receiver operation as shown in Figure 4-28, page 4-63.

NOTE

- DO NOT ALTER SETTING OF INT MOD CONTROL (23).

3. Set FM/AM-1000S/A controls for oscilloscope operation as shown in Figure 4-1, page 4-5.

4. Set EXT V/DIV Control (31) to "1.5 kHz", "6 kHz" or "15 kHz" position.

5. Adjust INTENSITY Control (35) cw and FOCUS Control (37) appropriately to obtain a sharp visible trace display.

NOTE

- Warm-up time of CRT is approximately 30 seconds from a "cold" start-up; trace display will not become visible until CRT achieves warm-up.

6. Oscilloscope should now display a noise level of approximately 2.5 to 3 graticule divisions in amplitude.

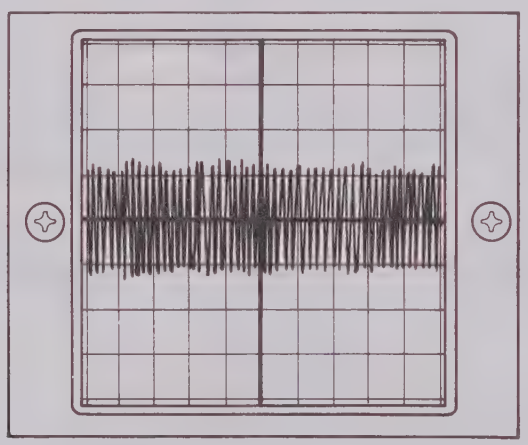


FIGURE 4-100 NOISE LEVEL DISPLAY OF APPOX. 2.5 GRATICULE DIVISIONS (PEAK-TO-PEAK)

7. Adjust VERT Control (38) and HORIZ Control (36) to center scope display over major horizontal axis of CRT.

8. Apply power to UUT.

STEP	PROCEDURE

9. Key up UUT while observing oscilloscope display. While keying UUT, rotate VERT Control (38) so negative peaks of modulation envelope rest on any horizontal axis.

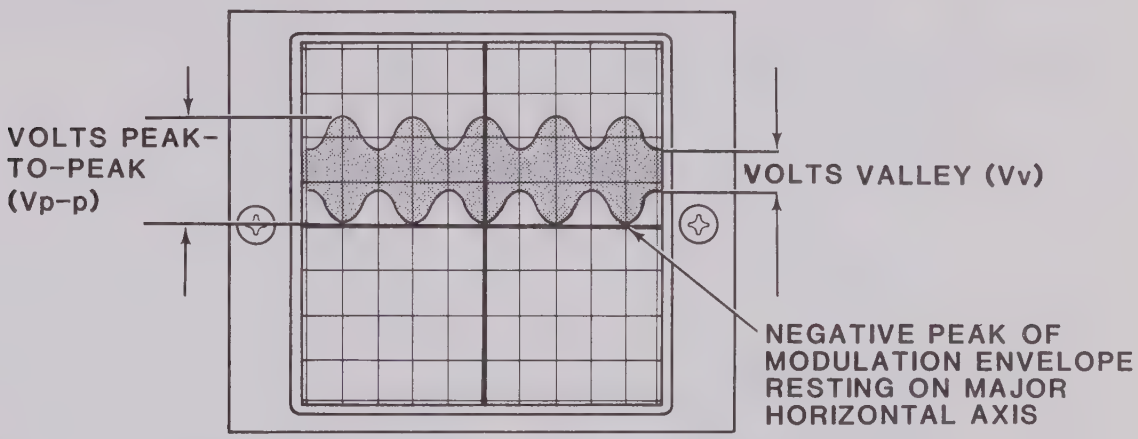


FIGURE 4-101 NEGATIVE PEAKS OF MODULATION ENVELOPE RESTING ON MAJOR HORIZONTAL AXIS

10. Measure Volts peak-to-peak (Vp-p) (in major graticule divisions) of displayed modulation envelope. Record result.

11. Measure distance Volts valley (Vv) (in major graticule divisions) of displayed modulation envelope. Record result.

12. To determine "percent modulation", apply result of Steps 10 and 11 to following equation:

$$\frac{(Vp\text{-}p) - Vv}{(Vp\text{-}p) + Vv} \times 100 = \% \text{ Modulation}$$

4-9-5

TEST PROCEDURE: ***MEASURING TRANSMITTER DEVIATION (BELOW ± 20 kHz)***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D:

1 BNC "Tee" Connector

2 Coax cables with BNC male connectors on one end and appropriate UUT connectors on opposite end

1 Short coax cable with BNC male connector on each end

1 DC blocking capacitor

TEST SET-UP DIAGRAM:

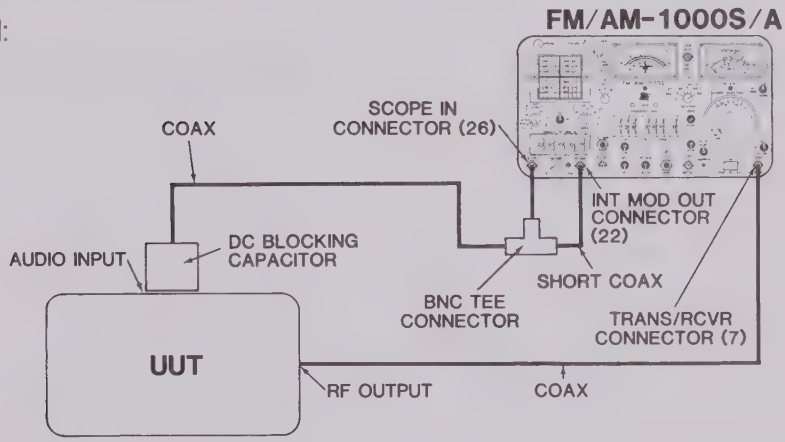


FIGURE 4-102 TEST SET-UP DIAGRAM FOR MEASURING TRANSMITTER DEVIATION

STEP	PROCEDURE
1.	Perform procedure 4-4-3, titled "GENERATING AUDIO TONES OF KNOWN AMPLITUDE", on page 4-47. Frequency of audio tone to be generated is 1 kHz; set MODULATION FREQ Hz Thumbwheels (25) 1000.0 Hz.

NOTE

- Amplitude of injected 1 kHz audio tone must be within limits of UUT input specifications.
- Tone injection point on UUT is "Audio Input" or "Microphone Jack."

2.	Set FM/AM-1000S/A controls for FM receiver operation as shown in Figure 4-28, page 4-63.

STEP	PROCEDURE
3.	Place DEV/PWR Control (47) to "20 kHz" position.
4.	Key up UUT and proceed to Step 5.
5.	Observe reading of DEVIATION/WATTS Meter (1):

a. If reading on uppermost scale of meter is less than 6 kHz, rotate DEV/PWR Control (47) to "6 kHz" position and proceed to Step 5b. If reading is above 6 kHz, proceed directly to Step 5c.

b. If reading on middle scale is less than 2 kHz, rotate DEV/PWR Control (47) to "2 kHz" position and proceed to Step 5c. If reading is above 2 kHz, proceed directly to Step 5c.

c. Record reading of meter. Result represents peak FM deviation of UUT.

SECTION 5 - RECEIVER ALIGNMENT AND TROUBLESHOOTING

5-1 GENERAL

This section contains instructions for aligning and troubleshooting most typical AM/FM receivers, using the FM/AM-1000S/A. For ease of understanding the alignment/troubleshooting thought process, most of the information contained in this section is presented in the form of logical flowcharts. These flowcharts will enable operator to evaluate overall UUT performance and will provide a systematic means of localizing/correcting common receiver problems.

NOTE

- The receiver alignment/troubleshooting procedures contained in this manual are provided primarily for the benefit of the novice technician.

The information contained in this section is divided into the following subsections:

Section	Title
5-2	ROUTINE MAINTENANCE CHECKLIST
5-3	AM/FM RECEIVER ALIGNMENT FLOWCHART
5-4	AM/FM RECEIVER TROUBLESHOOTING FLOWCHARTS
5-4-1	Power Supply Troubleshooting Flowchart
5-4-2	Oscillator Troubleshooting Flowchart
5-4-3	RF Amplifier Troubleshooting Flowchart
5-4-4	IF Amplifier Troubleshooting Flowchart
5-4-5	Receiver Section Troubleshooting Flowchart
5-4-6	Squelch Troubleshooting Flowchart
5-4-7	AGC Troubleshooting Flowchart
5-4-8	AM Audio Troubleshooting Flowchart
5-4-9	Sensitivity Troubleshooting Flowchart
5-4-10	Squelch Enable Troubleshooting Flowchart
5-4-11	FM Audio Troubleshooting Flowchart
5-4-12	Maximum Receivable Deviation Troubleshooting Flowchart

5-1-1 PRELIMINARY CONSIDERATIONS

1. For maximum benefit of all the alignment/troubleshooting procedures contained herein, it is strongly recommended that operator be familiar with the circuit under test so some idea is perceived as to voltage, frequency and waveform to be expected at each test point. This knowledge will aid operator in performing the alignment/troubleshooting procedures in a logical efficient manner, with a minimum of blind searching.

2. The flowcharts contained in this section are primarily intended to cover those receiver problems which occur continuously, as opposed to those occurring intermittantly or at random intervals. Intermittant problems are more difficult to troubleshoot because of the difficulty in making the malfunction occur on cue. With this type of problem, operator should strive to:

5-1-1 PRELIMINARY CONSIDERATIONS (CONT'D)

a. Determine conditions under which problem is most likely to occur.

b. Simulate those conditions so the problem can be corrected.

Examples of intermittant type problems are:

(1) Malfunctions related to temperature (e.g. UUT operates satisfactorily for a period when first energized; when UUT achieves warm-up, malfunction occurs).

(2) Malfunctions related to vibration (e.g. UUT operates satisfactorily in a test bench environment, but not under mobile conditions).

(3) Malfunctions related to control position, mode or range. (e.g. malfunction occurs only when a given UUT control is in a certain position).

3. As a prerequisite to performing the procedures contained in this section, it is recommended that operator obtain as much technical data as possible on UUT. (Data should include block diagrams, schematics, specifications and if available, maintenance procedures recommended by UUT manufacturer.) This information will be useful in providing location of test points, correct test point values, correct input/output specifications as well as details relative to overall UUT design.

5-1-2 ALIGNMENT/TROUBLESHOOTING SAFETY PRECAUTIONS

In addition to the general safety precautions listed under Section 2-1-1 of this manual, the operator must observe the following additional alignment/troubleshooting precautions:

1. When working with "live" circuits of high potential, keep one hand in pocket or behind back to avoid serious shock hazard.

2. Remove all jewelry or other cosmetic apparel before performing any test procedures involving "live" circuits.

3. Use only insulated troubleshooting tools when working with "live" circuits.

4. For added insulation, place rubber bench mat underneath all powered bench equipment, as well as a rubber floor mat underneath operator chair.

5. Heed all WARNINGS and CAUTIONS concerning maximum voltage and power inputs.

5-1-2 ALIGNMENT/TROUBLESHOOTING SAFETY PRECAUTIONS (CONT'D)

6. Avoid using oscilloscope/spectrum analyzer in direct sunlight as scope trace is difficult to see under these conditions.

7. Do not allow scope trace to become concentrated on CRT as a stationary spot, as CRT screen may be burned permanently. Reduce trace intensity if trace must remain stationary.

8. Protect FM/AM-1000S/A from vibration or mechanical shock. The CRT of the FM/AM-1000S/A is highly evacuated and if broken, will implode causing possible serious injury from fragmented glass.

5-1-3 HOW TO USE ALIGNMENT/TROUBLESHOOTING FLOWCHARTS

To begin the alignment/troubleshooting process, perform procedures below in sequence given:

1. ROUTINE MAINTENANCE CHECKLIST (Section 5-2)
   Requires visual inspection of UUT exterior and interior components.

2. RECEIVER ALIGNMENT FLOWCHART (Section 5-3)
   The alignment chart serves as initial starting point for determining overall UUT performance as follows:

   a. For instructions on how to perform certain alignment procedures using FM/AM-1000S/A, operator will be referred to appropriate test procedure in "SECTION 4, OPERATION" of this manual. On the alignment flowchart, those references will appear within the following symbol:

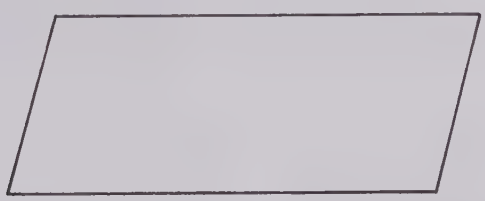


FIGURE 5-1 FLOWCHART SYMBOL REFERENCING AN OPERATING TEST PROCEDURE CONTAINED IN SECTION 4

   b. If during the course of alignment, certain UUT performance parameters do not meet expected norm, operator will be referred to troubleshooting flowcharts in "SECTION 5-4" of this manual. These flowcharts will provide general recommendations for troubleshooting various stages of the UUT.

5-1-3 HOW TO USE ALIGNMENT/TROUBLESHOOTING FLOWCHARTS (CONT'D)

b. (cont'd)
On the alignment chart, references to a given troubleshooting flowchart will appear within following symbol:

FIGURE 5-2 FLOWCHART SYMBOL REFERENCING A TROUBLESHOOTING FLOWCHART CONTAINED IN SECTION 5

c. Once a UUT performance problem has been located and corrected, operator is directed to a "RETURN" block (as shown below) at conclusion of troubleshooting flowchart. This block requires operator to return to "START" block of "RECEIVER ALIGNMENT FLOWCHART" and repeat all steps of the alignment procedure.

FIGURE 5-3 FLOWCHART SYMBOL DIRECTING OPERATOR TO RETURN TO "START" OF "RECEIVER ALIGNMENT FLOWCHART"

5-2 ROUTINE MAINTENANCE CHECKLIST

This section provides a checklist useful in determining the physical condition of a UUT through visual inspection. Defects resulting from wear, physical damage or deterioration can be detected using this checklist.

WARNING

- Power to UUT must be disconnected while completing entire checklist.

1. INSPECT UUT EXTERIOR FOR VISIBLE DAMAGE (Repair or replace damaged components as required):

   a. Check for scratches, dents, punctures, badly worn areas, broken covers or other evidence reflective of possible internal damage.

   b. Check for burned or scorched paint on UUT covers indicating possible UUT overheating.

   c. Check for clogged cooling vents or air filters.

   d. Check for evidence of corrosion.

2. INSPECT UUT CONTROLS AND INDICATORS FOR DEFECTIVE OR DAMAGED HARDWARE (Repair or replace damaged components as required):

   a. Check for loose control knobs.

   b. Check for cracked or broken bezels, lamps etc.

   c. Check for burned out indicator lamps.

   d. Check for defective control knob or switch detents.

3. INSPECT UUT CONNECTORS FOR VISIBLE DAMAGE (Repair or replace damaged components as required):

   a. Check for corroded contacts, pins etc.

   b. Check for loose, bent or broken pins.

   c. Check for damaged connector housings or insulation.

   d. Check for improperly soldered or broken connections.

5-2 ROUTINE MAINTENANCE CHECKLIST (CONT'D)

4. WITH UUT COVERS OFF, CLEAN INNER COMPONENTS OF UUT:

   Recommended cleaning supplies: Denatured alcohol, soft bristle brush, lint-free cloth and hand controlled dry air jet (30 psi maximum pressure).

   a. Remove dust and dirt from all electrical components. (Dust all components with bristle brush or dry air jet and where applicable, clean with lint-free cloth moistened with denatured alcohol.)

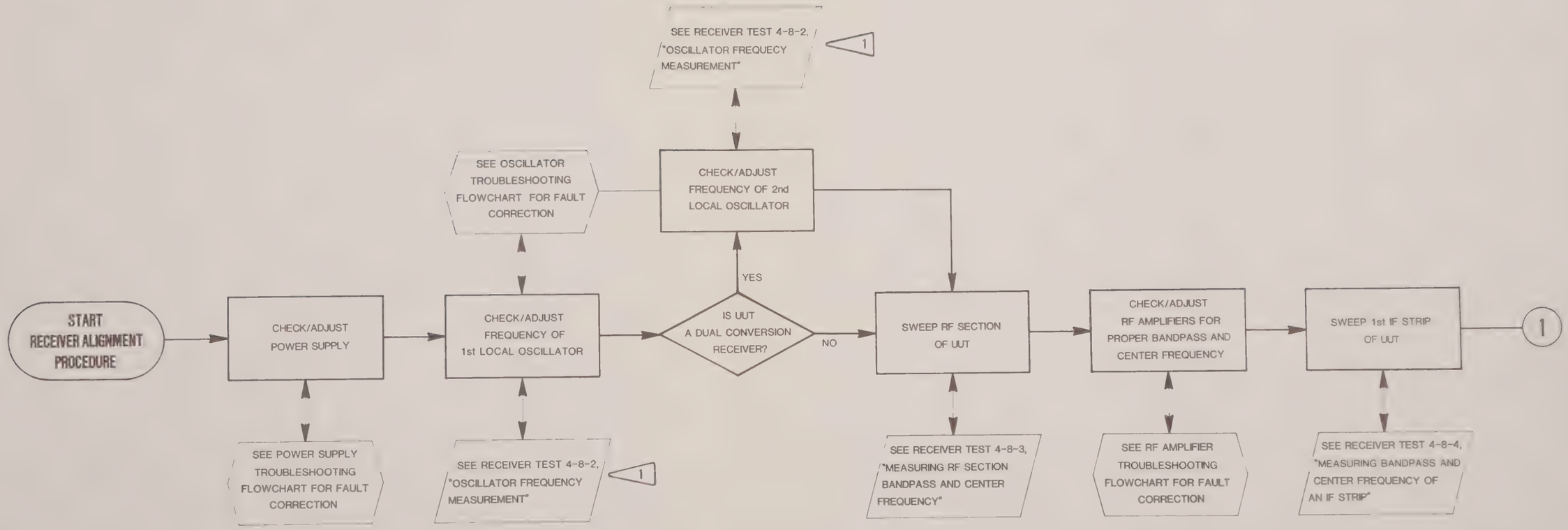
   CAUTION

   - Use air jet cautiously to avoid damaging fragile components.

   b. Clean all accessible switch and relay contacts.

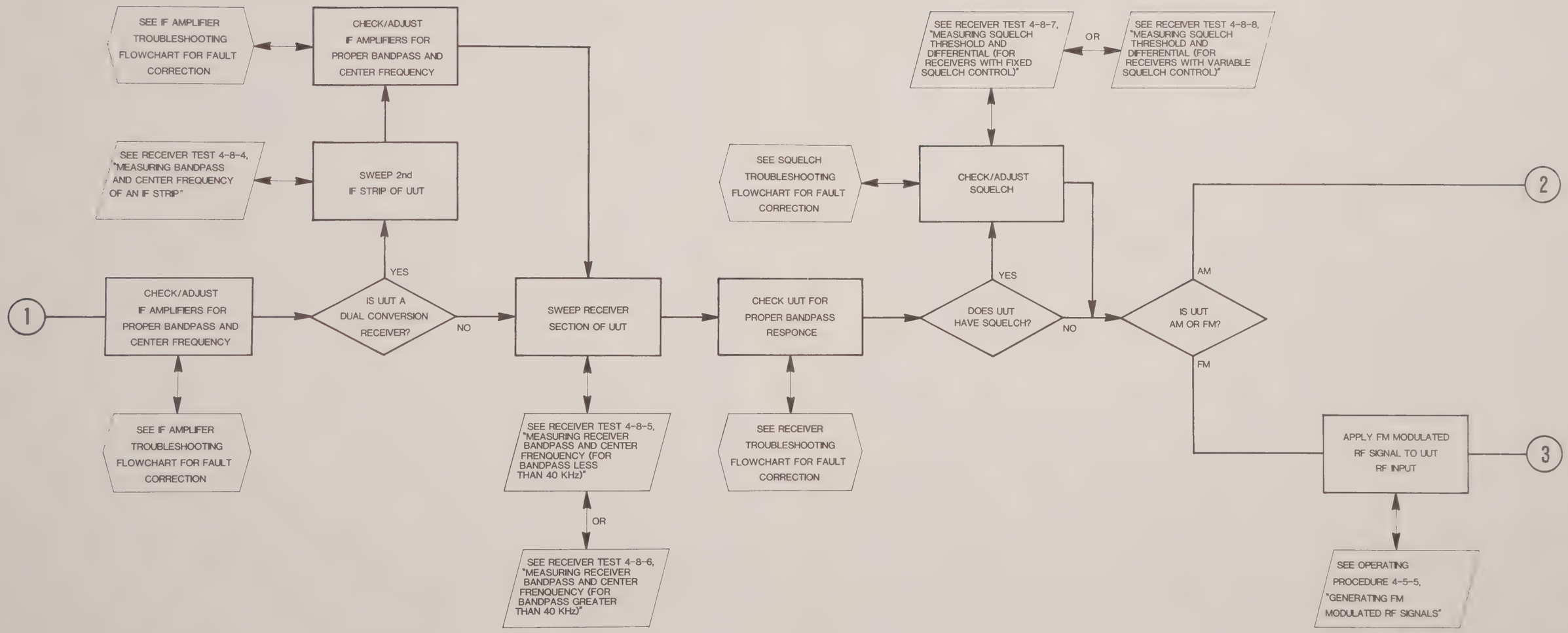
   c. Use denatured alcohol to clean any corroded areas.

   d. Inspect for any leaky components. Replace as necessary.

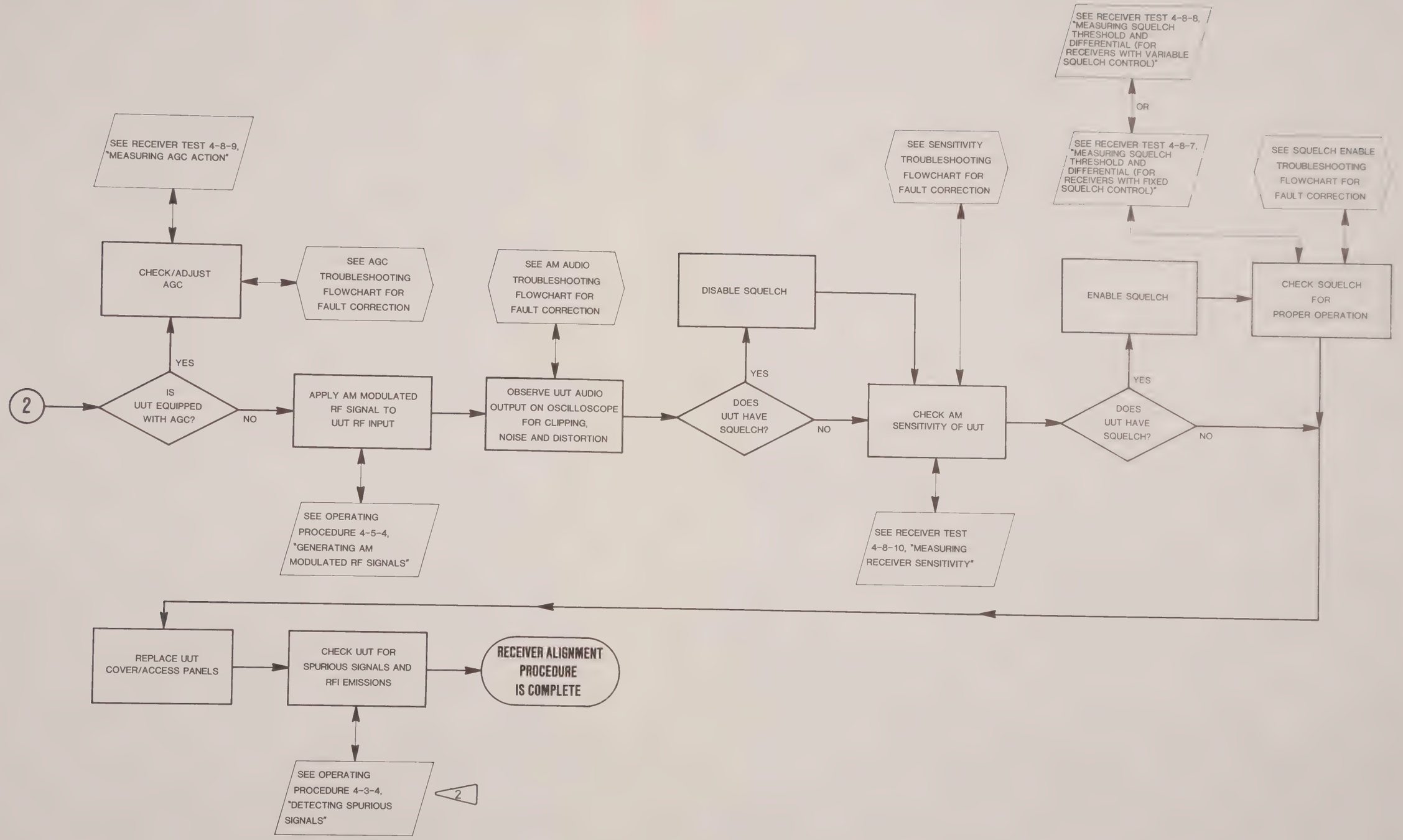


1 Test Procedure 4-2-8 applies to FM/AM-1000S models only, while Test Procedure 4-2-8A applies to FM/AM-1000A models.

5-3
RECEIVER ALIGNMENT FLOWCHART

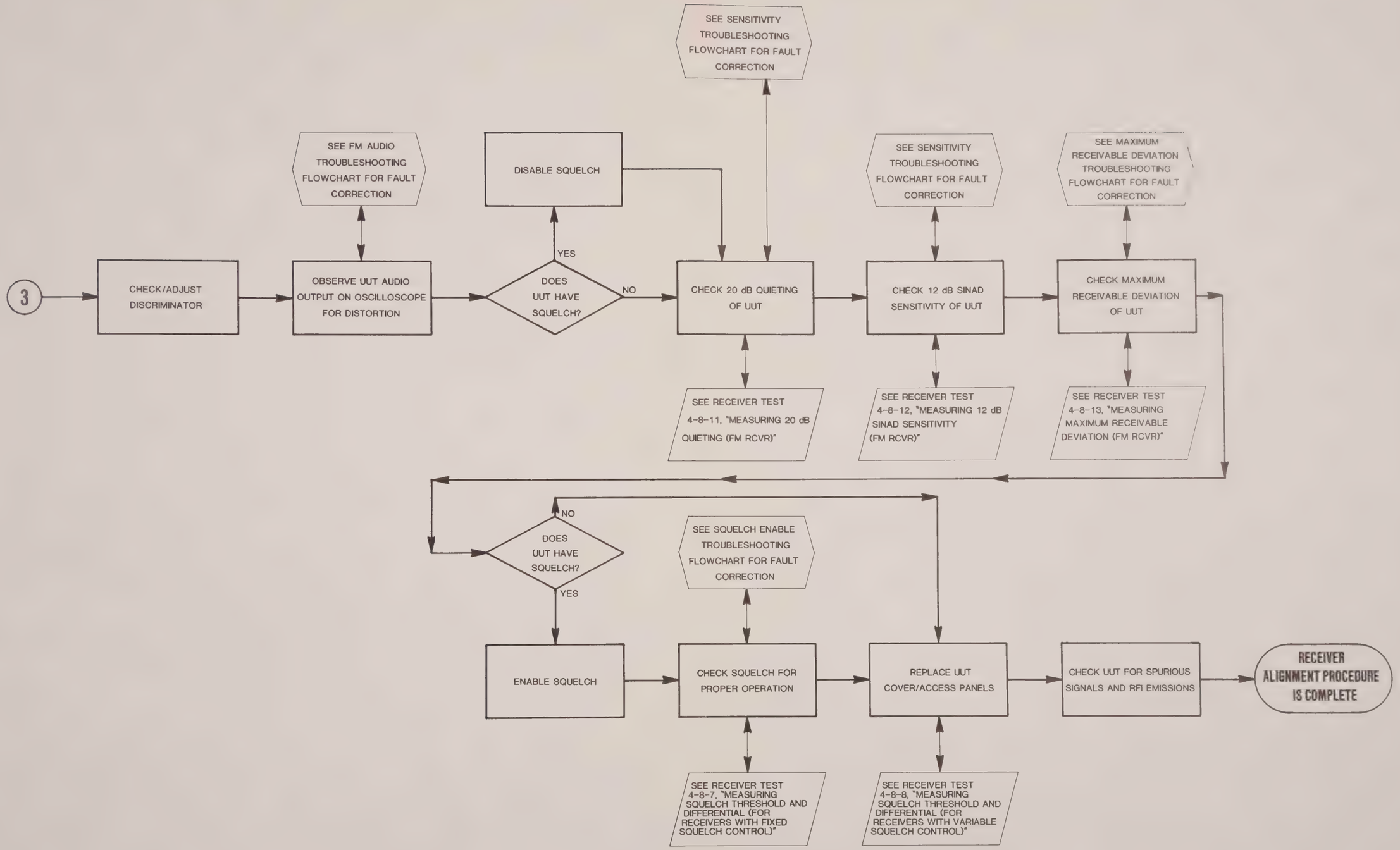


5-3 RECEIVER ALIGNMENT FLOWCHART



2 Test Procedure 4-3-4 applies to FM/AM-1000S models only.

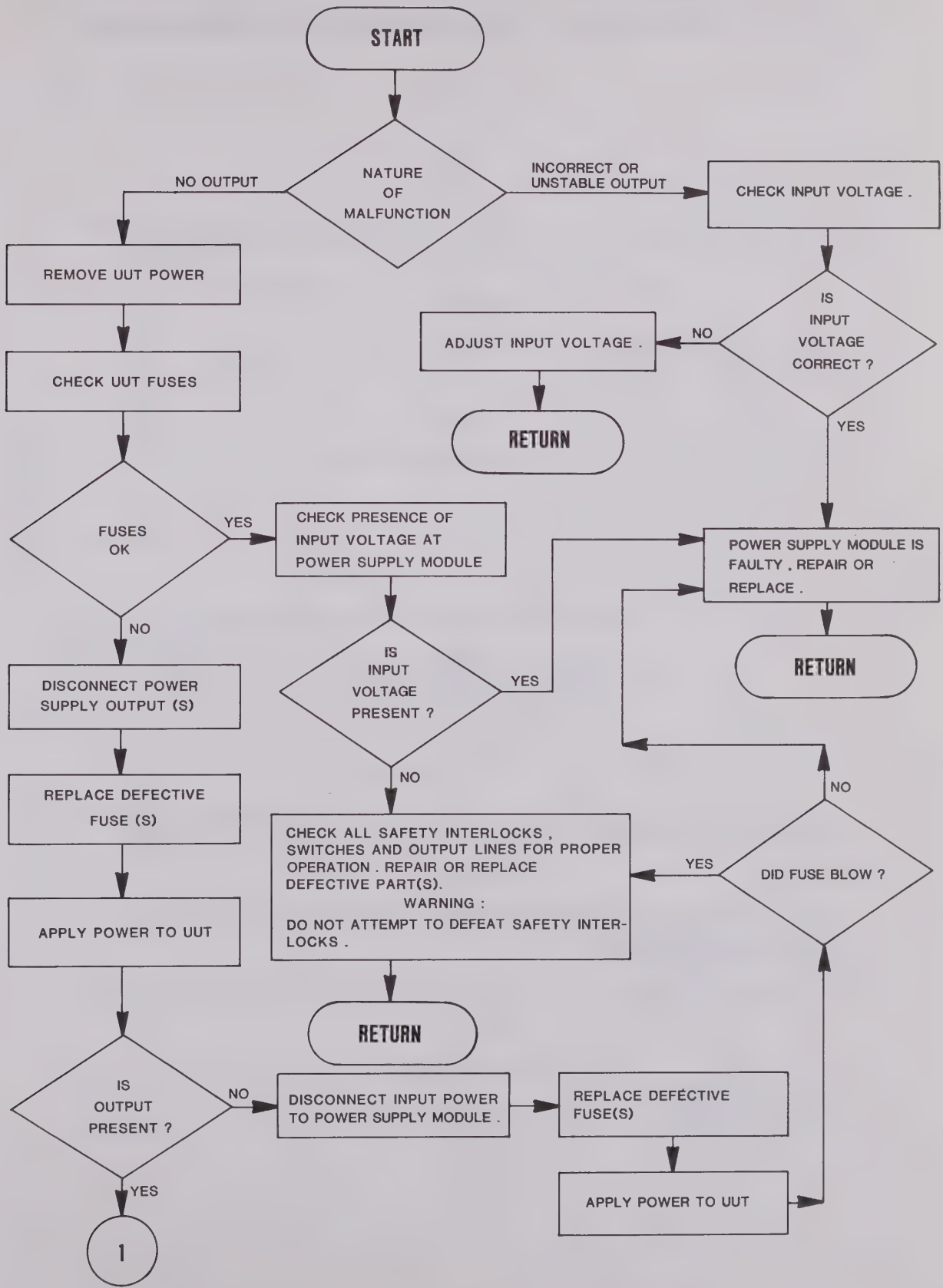
5-3 RECEIVER ALIGNMENT FLOWCHART



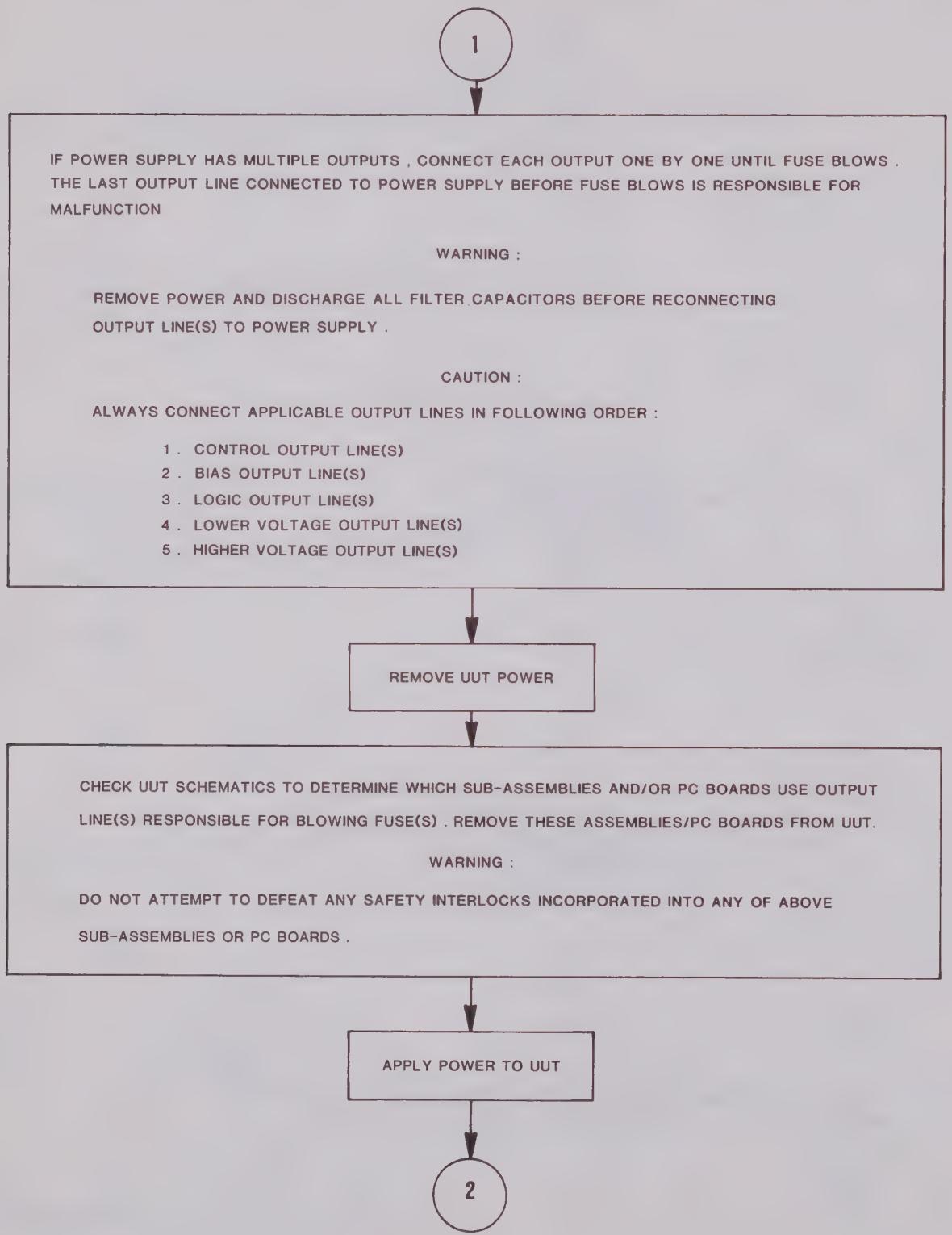
5-3
RECEIVER
ALIGNMENT
FLOWCHART

5-4 AM/FM RECEIVER TROUBLESHOOTING FLOWCHARTS

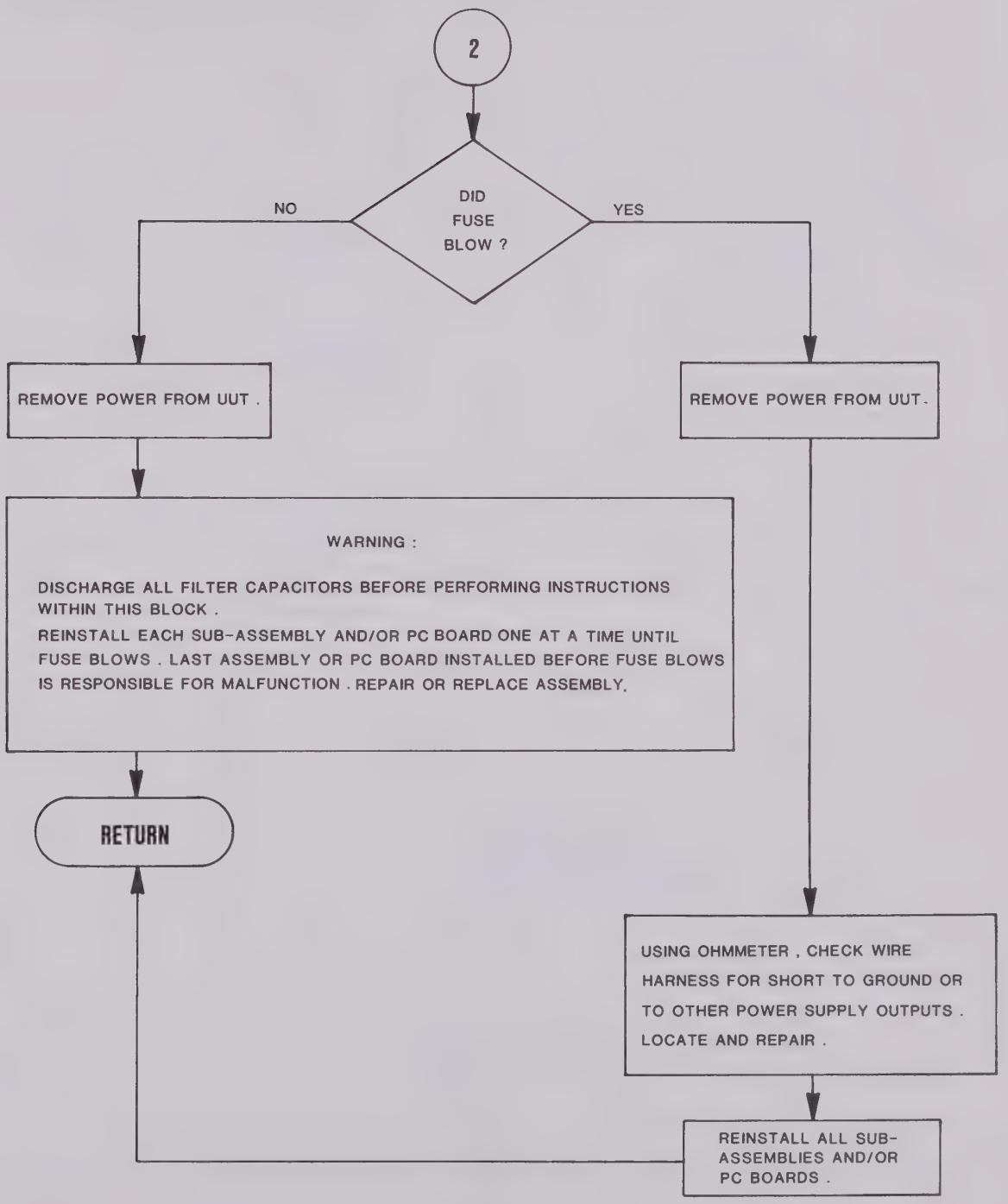
5-4-1 POWER SUPPLY TROUBLESHOOTING FLOWCHART



5-4-1 POWER SUPPLY TROUBLESHOOTING FLOWCHART



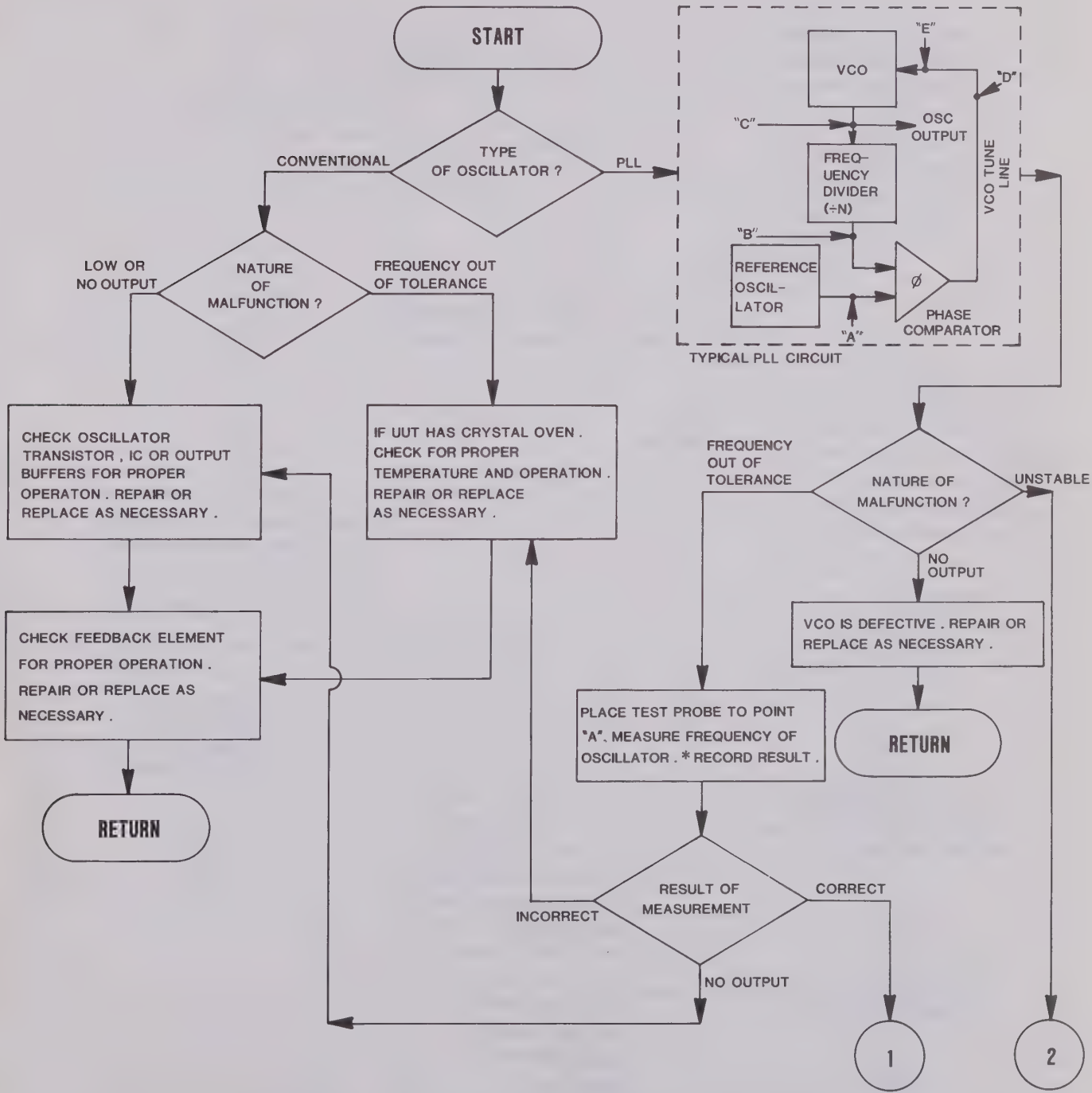
5-4-1 POWER SUPPLY TROUBLESHOOTING FLOWCHART



5-4-2 OSCILLATOR TROUBLESHOOTING FLOWCHART
(REFERENCE TEST PROCEDURE 4-8-2 IN SECTION 4)

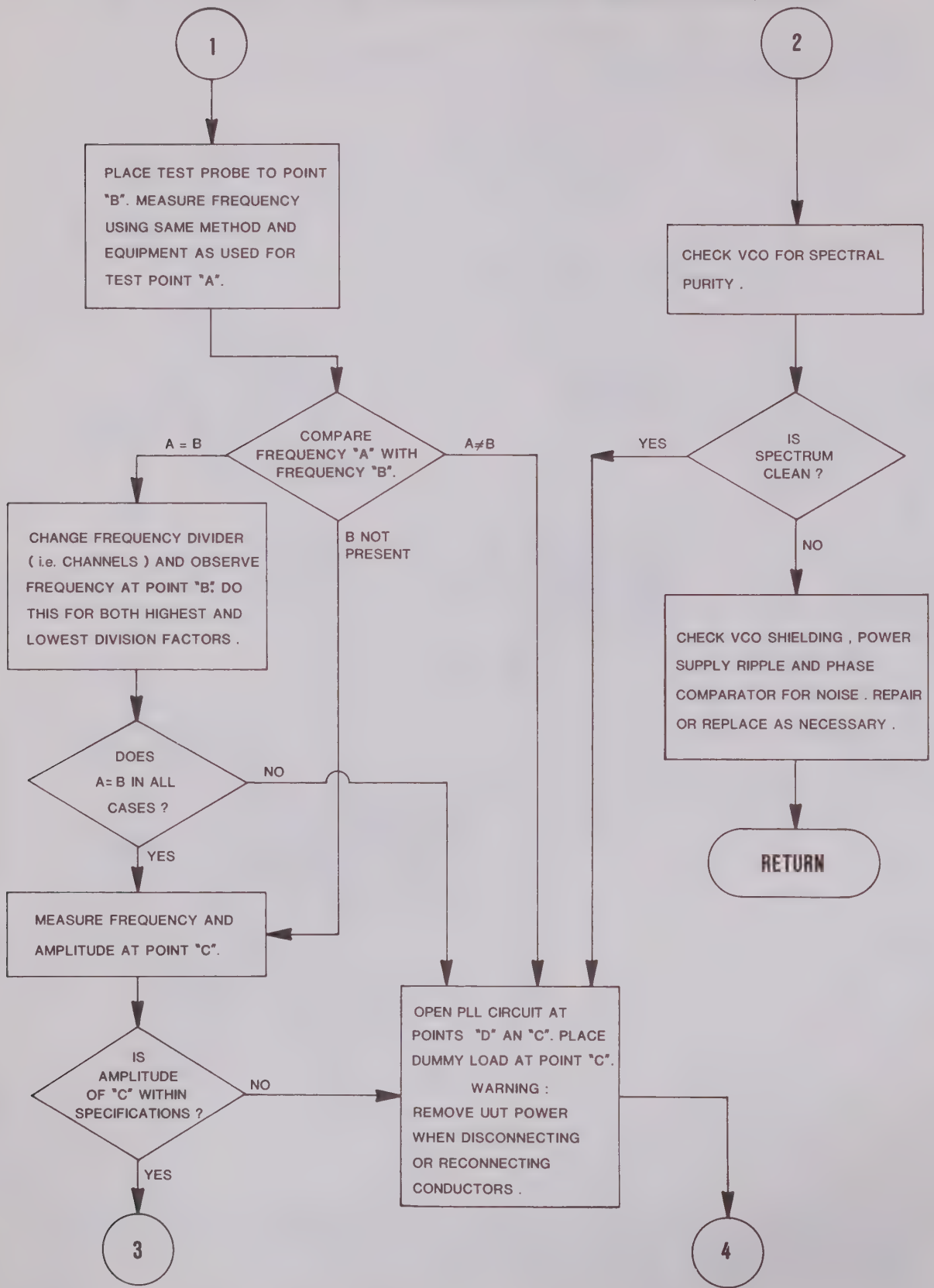
NOTE :

OSCILLATOR UNDER TEST MUST BE PHYSICALLY LOCATED ON UUT AND IDENTIFIED ON UUT SCHEMATIC BEFORE PERFORMING TROUBLESHOOTING STEPS BELOW .

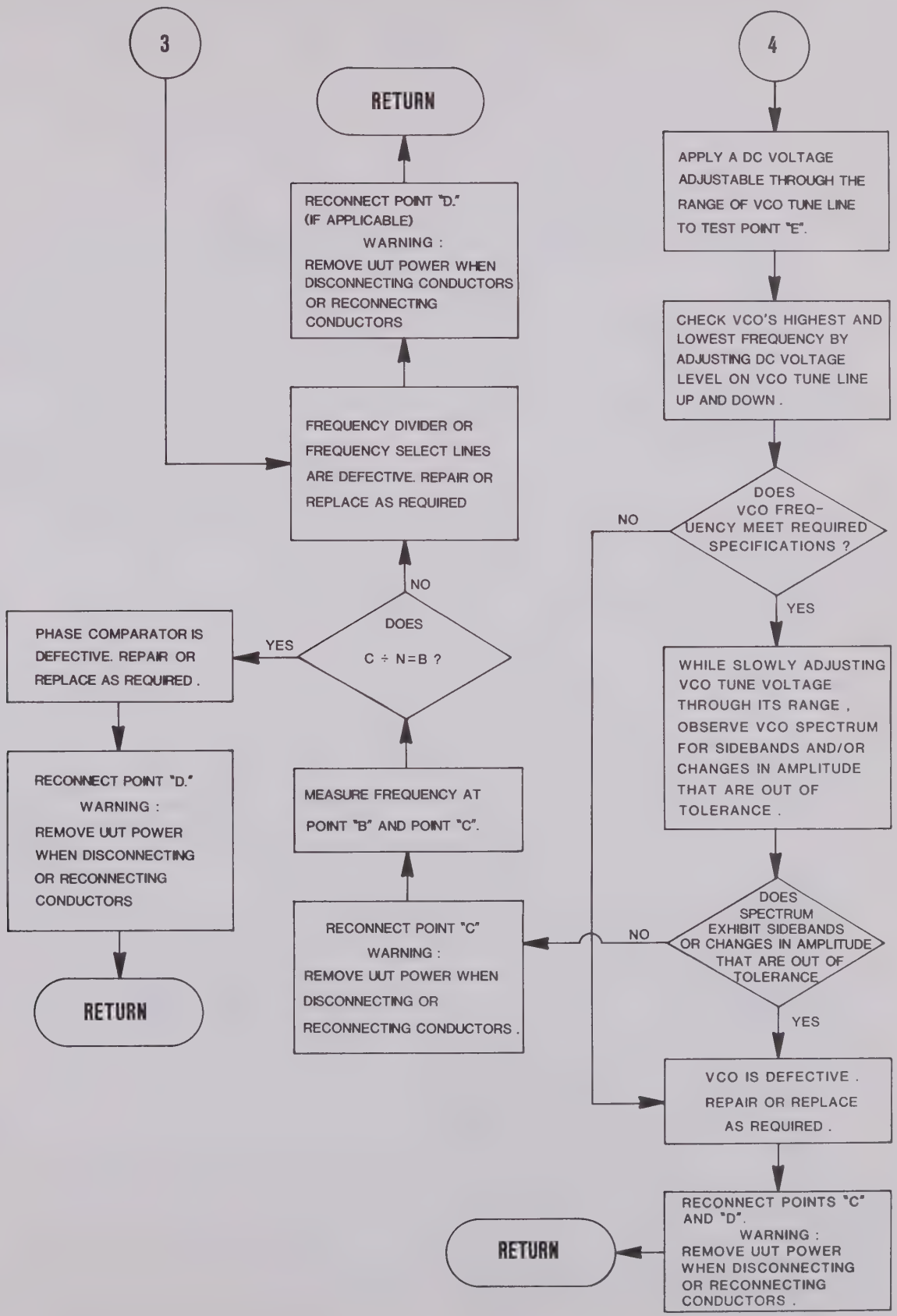


* CHECK UUT SCHEMATIC FOR OSCILLATOR FREQUENCY RANGE . IF BELOW 50 kHz , MEASURE FREQUENCY USING OPERATING PROCEDURE 4-2-7 "MEASURING FREQUENCIES BETWEEN 5 Hz AND 500 KHz" (STEPS 12 THRU 17) . IF ABOVE 50 KHz , MEASURE FREQUENCY USING FREQUENCY COUNTER .

5-4-2 OSCILLATOR TROUBLESHOOTING FLOWCHART

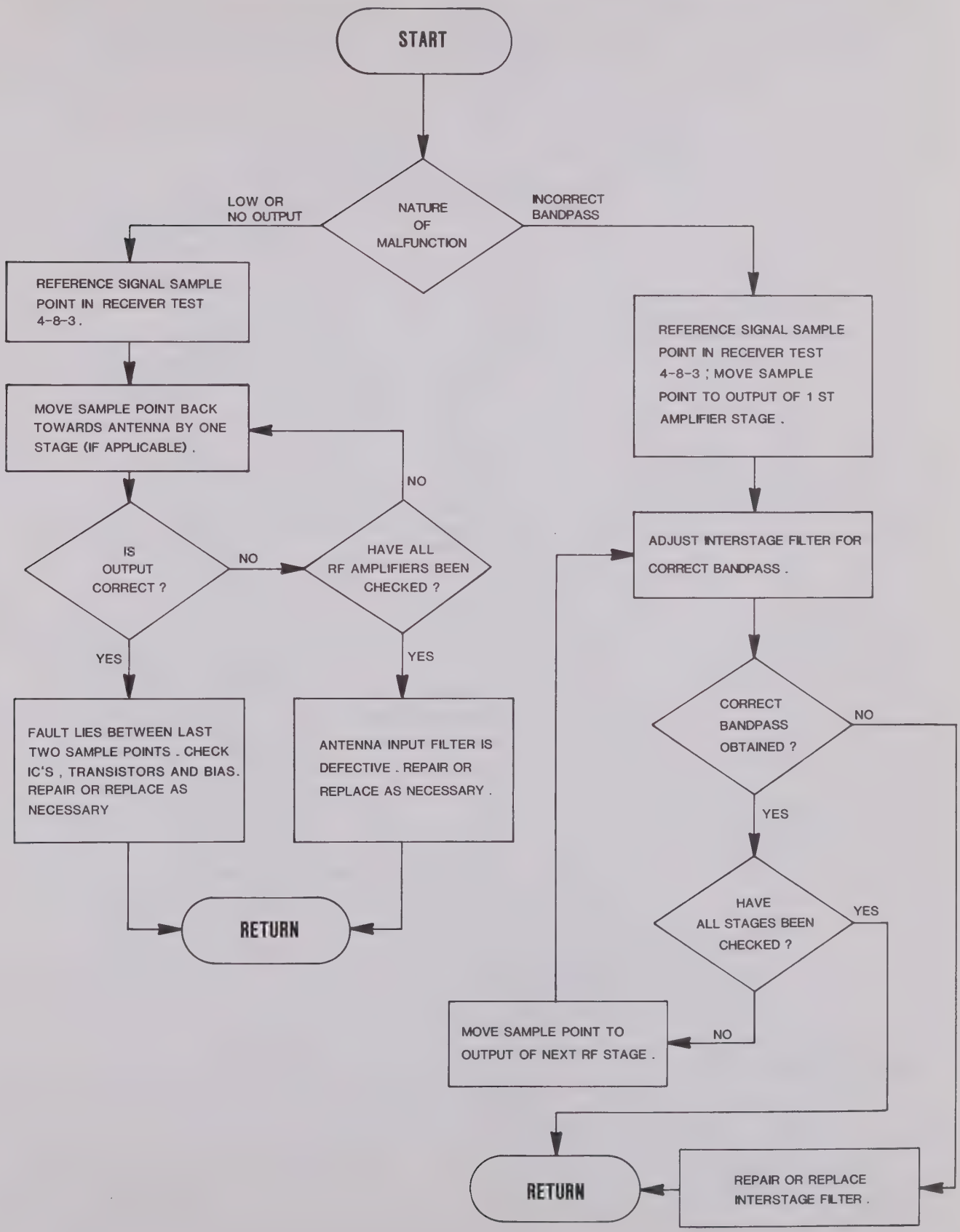


5-4-2 OSCILLATOR TROUBLESHOOTING FLOWCHART



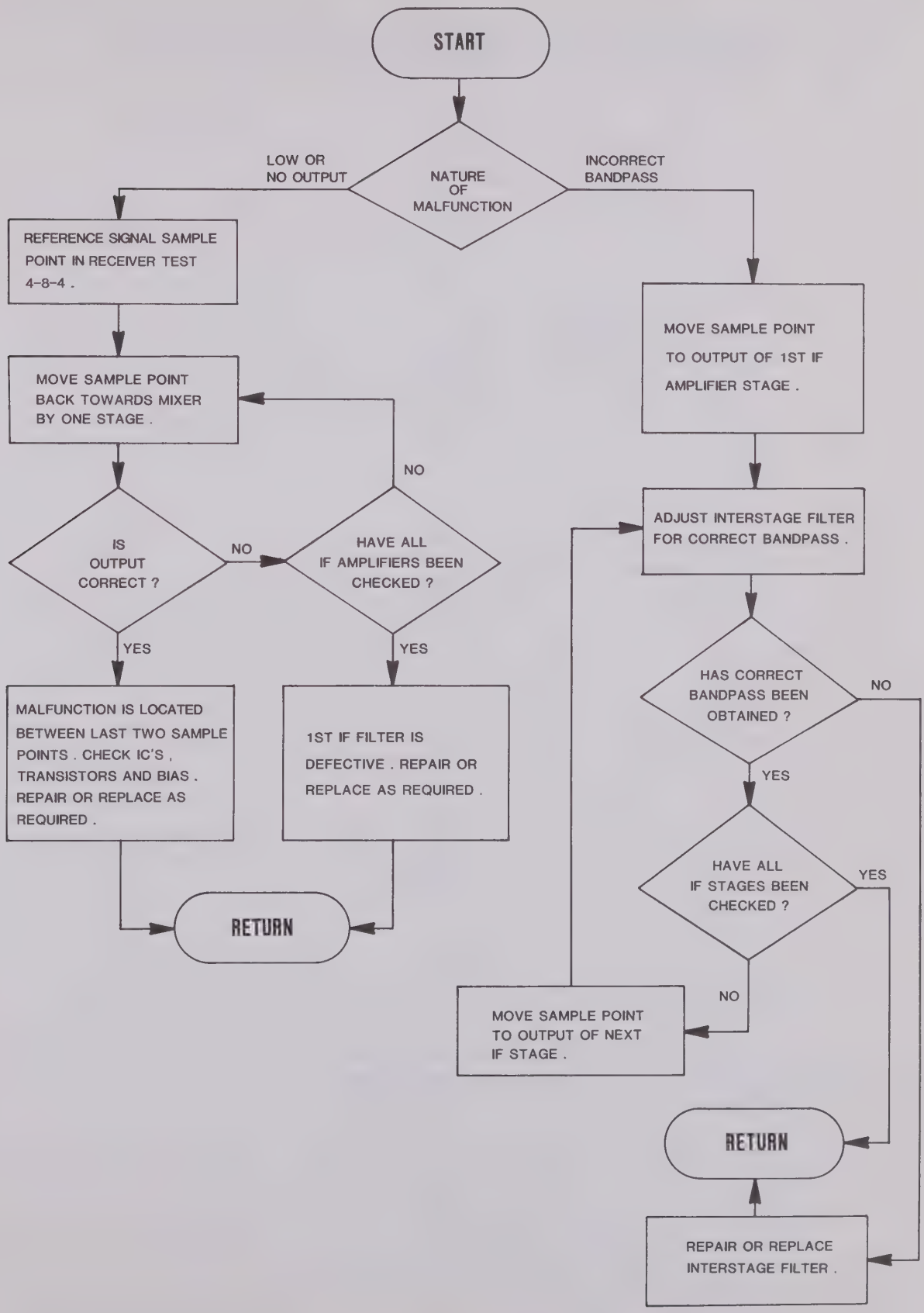
5-4-3 RF AMPLIFIER TROUBLESHOOTING FLOWCHART

(REFERENCE TEST PROCEDURE 4-8-3 IN SECTION 4)

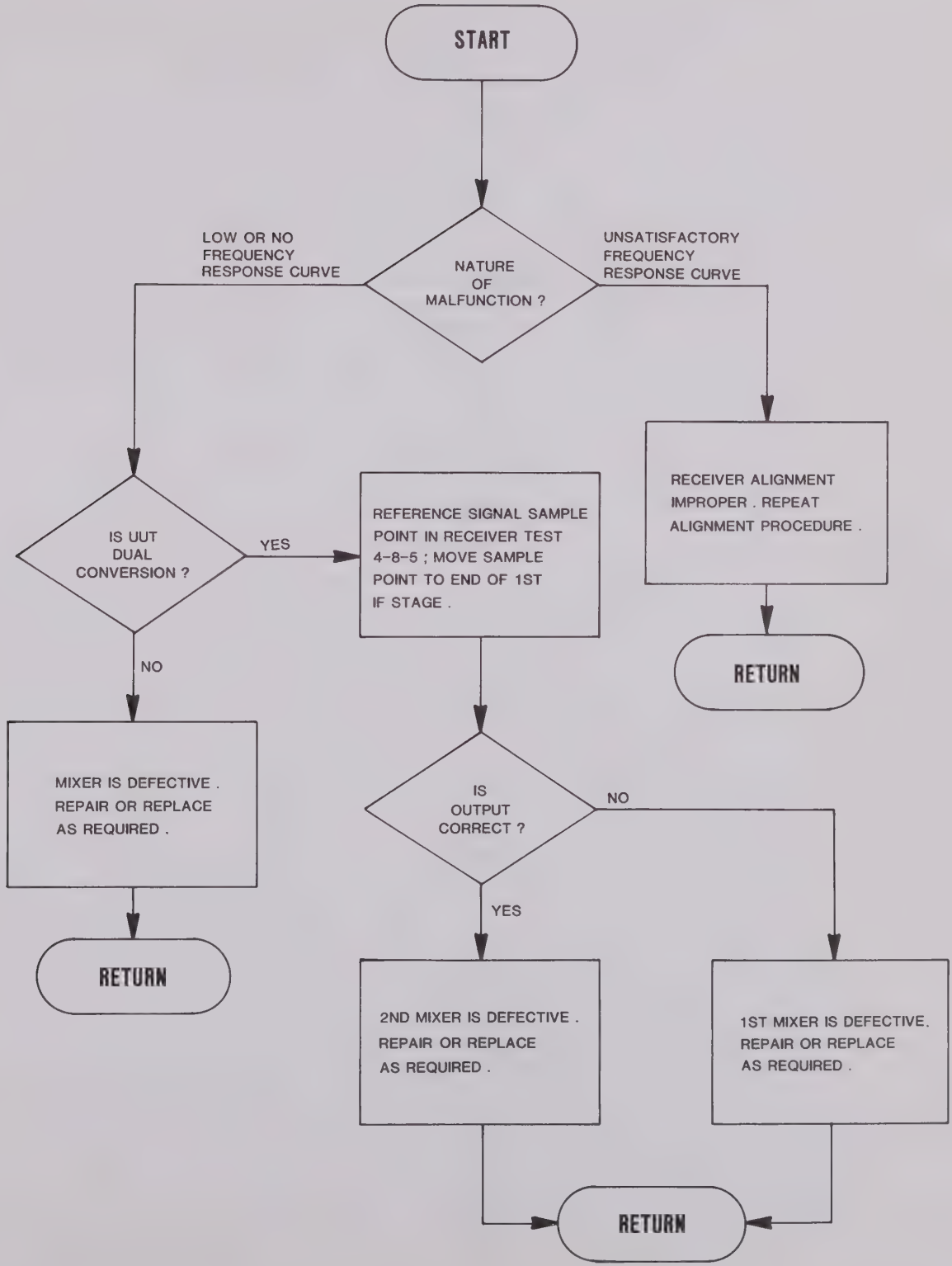


5-4-4 IF AMPLIFIER TROUBLESHOOTING FLOWCHART

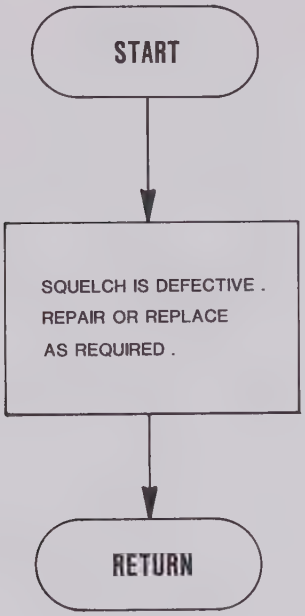
(REFERENCE TEST PROCEDURE 4-8-4 IN SECTION 4)



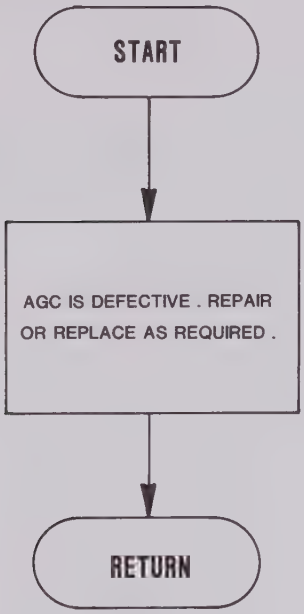
5-4-5 RECEIVER SECTION TROUBLESHOOTING FLOWCHART
(REFERENCE TEST PROCEDURE 4-8-5 IN SECTION 4)



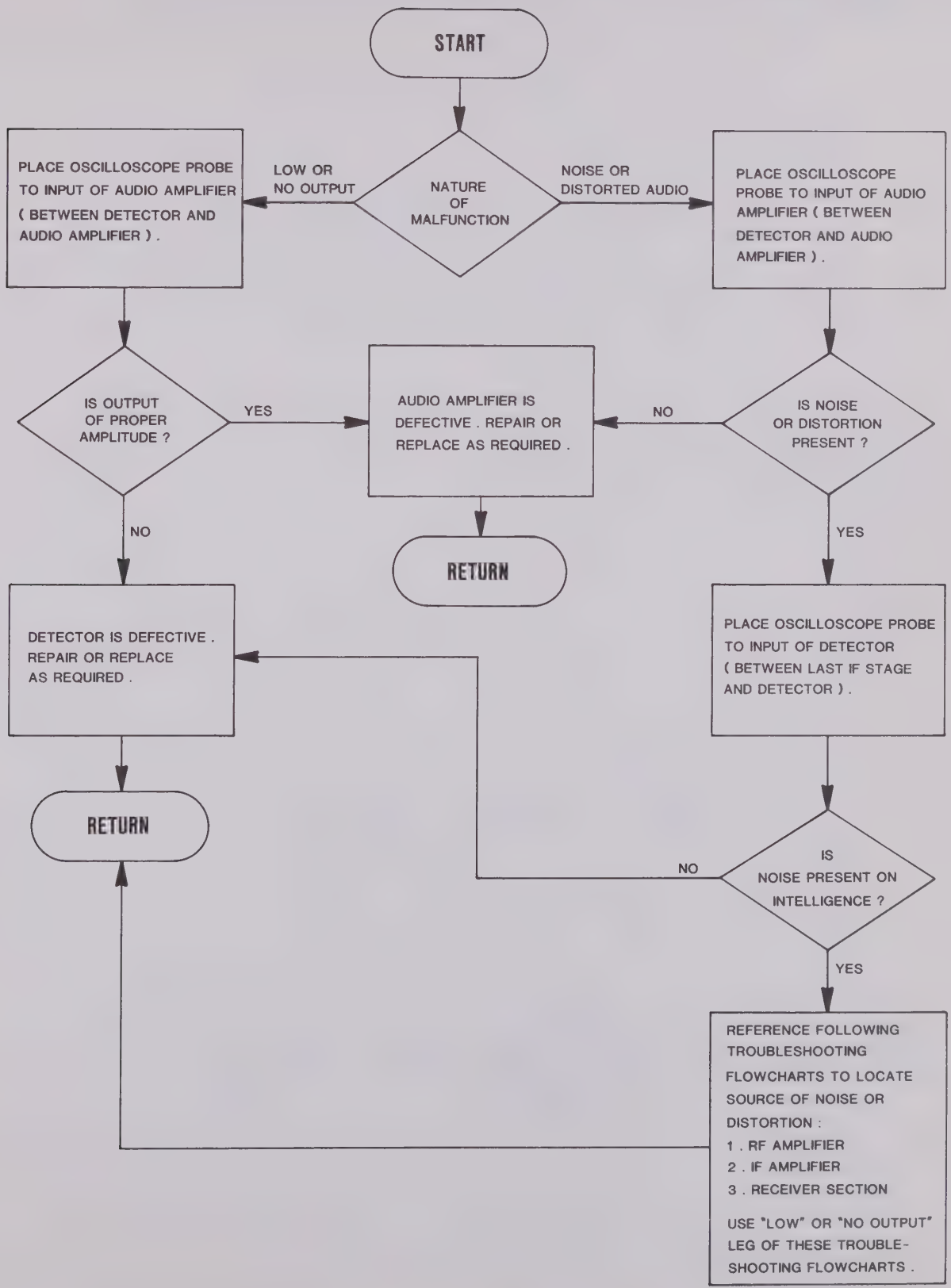
5-4-6 SQUELCH TROUBLESHOOTING FLOWCHART
(REFERENCE TEST PROCEDURES 4-8-7 OR 4-8-8 IN SECTION 4)



5-4-7 AGC TROUBLESHOOTING FLOWCHART
(REFERENCE TEST PROCEDURE 4-8-9 IN SECTION 4)

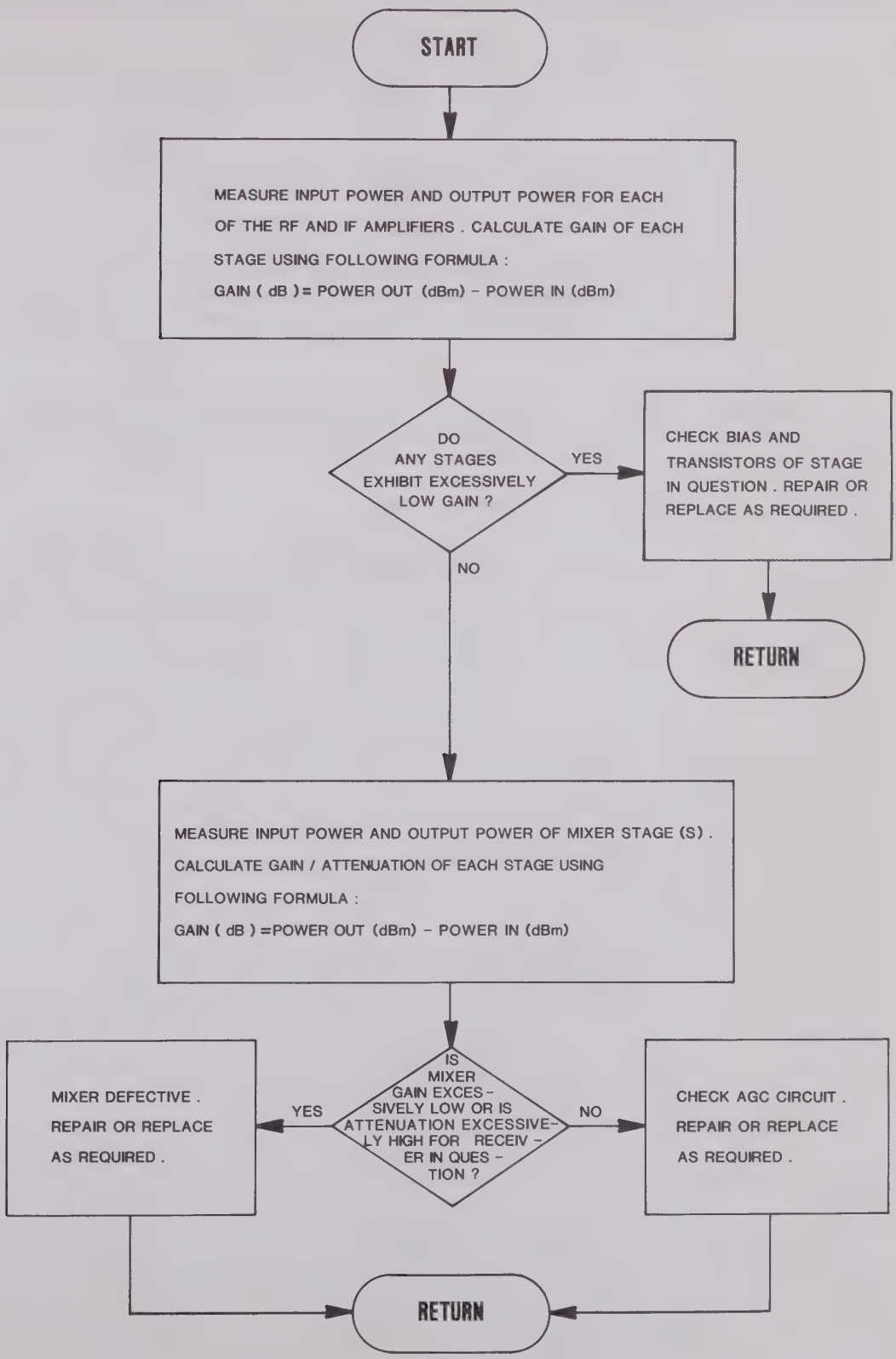


5-4-8 AM AUDIO TROUBLESHOOTING FLOWCHART



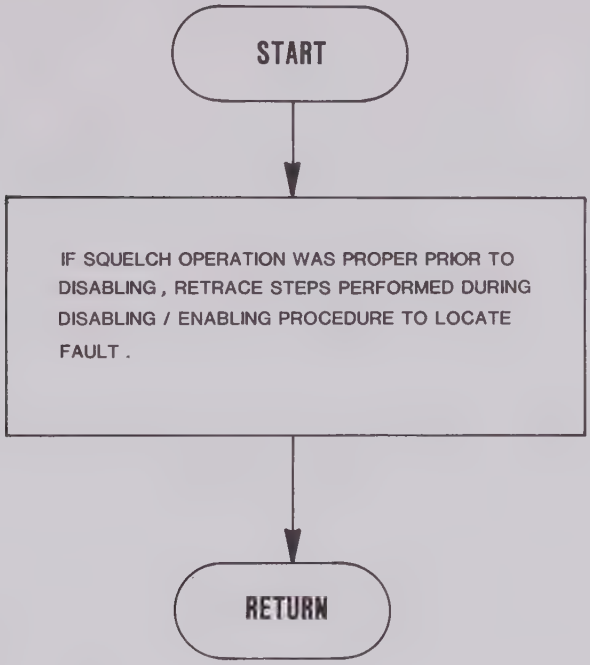
5-4-9 SENSITIVITY TROUBLESHOOTING FLOWCHART

(REFERENCE TEST PROCEDURES 4-8-10, 4-8-11 OR 4-8-12 IN SECTION 4)

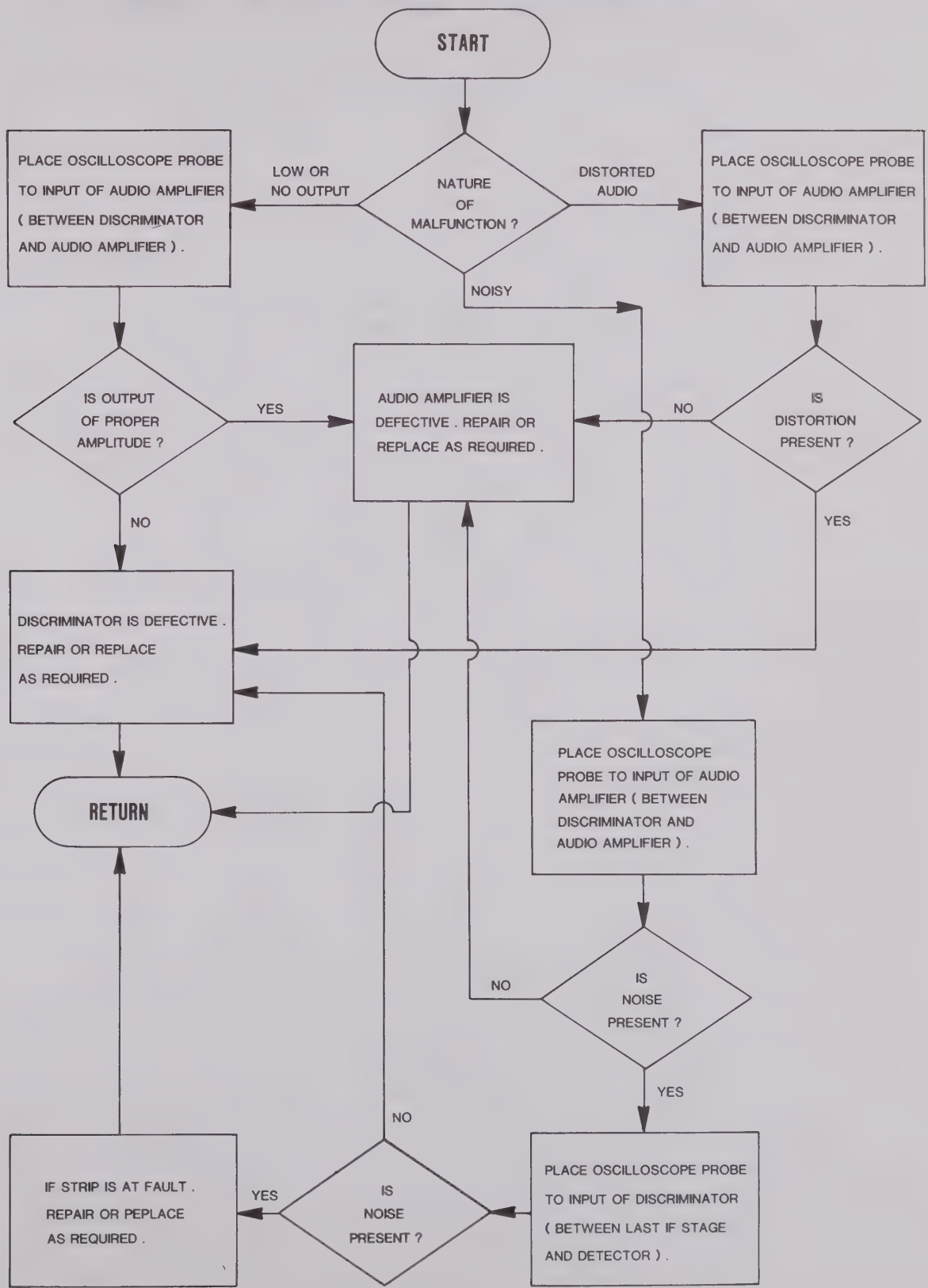


5-4-10 SQUELCH ENABLE TROUBLESHOOTING FLOWCHART

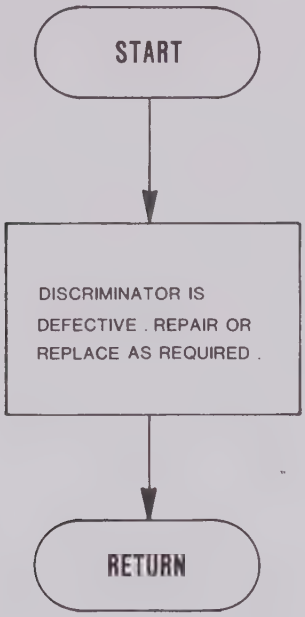
(REFERENCE TEST PROCEDURE 4-8-7 OR 4-8-8 IN SECTION 4)



5-4-11 FM AUDIO TROUBLESHOOTING FLOWCHART



5-4-12 MAXIMUM RECEIVABLE DEVIATION TROUBLESHOOTING FLOWCHART
(REFERENCE TEST PROCEDURE 4-8-13 IN SECTION 4)



APPENDICES

APPENDIX A: SPECIFICATIONS FM/AM-1000S (EFF: S/N 1616 & ON) AND FM/AM-1000A (EFF: S/N 1878 & ON)

RF SIGNAL GENERATOR

FREQUENCY RANGE:	100 Hz to 999.9999 MHz in 100 Hz increments
FREQUENCY ACCURACY:	5×10^{-7} (±0.00005%) 2×10^{-7} (typically) (See specification on TCXO MASTER OSCILLATOR)
FM QUIETING:	42 dB below 3.3 kHz deviation at 1 kHz rate, as measured in a 0.3 to 3 kHz post detection bandwidth
RESIDUAL FM:	Less than 100 Hz (typically <50 Hz)
RF OUTPUT POWER*:	-130 dBm to -33 dBm (100 Hz to 1 GHz), -130 dBm to 0 dBm (20 kHz to 1 GHz); continuously variable into 50 Ω
RANGES:	"Normal" and "μV x 100" and "HIGH LEVEL" (0 dBm)
ACCURACY*:	-110 to -35 dBm ±2.5 dB up to 400 MHz, ±3.0 dB above 400 MHz
"HI LEVEL" POWER RANGE INDICATOR ACCURACY:	0 dBm; ±2.5 dB (20 kHz to 600 MHz), ±4.0 dB (600 MHz to 999.9999 MHz) Dial indicator accuracy (dBm scale) is maintained relative to 0 dBm indication.
INTERNAL MODULATION	
AM:	10 Hz to 5 kHz (0 to 90%)
FM:	10 Hz to 9999.9 Hz rate (0 to ±15 kHz deviation)
EXTERNAL MODULATION	
AM:	3.0 V (±1 V) peak-to-peak produces 90% modulation (maximum modulating frequency = 15 kHz)
FM:	6.0 V (±2 V) peak-to-peak produces 15 kHz deviation (maximum modulating frequency = 15 kHz)

* These specifications may not be complied with at certain frequencies.

OSCILLOSCOPE

DISPLAY SIZE:	5 x 5 cm
VERTICAL BANDWIDTH:	DC to 1 MHz (at 3 dB bandwidth)
EXTERNAL VERTICAL INPUT RANGES:	10 mV, 100 mV, 1 V, 10 V per division
HORIZONTAL SWEEP RATE:	10 mSec, 1 mSec, 100 µSec, 10 µSec per division

SPECTRUM ANALYZER (NOTE: Spectrum Analyzer specifications are not applicable to FM/AM-1000A models.)

DYNAMIC RANGE:	70 dB (-30 dBm to -100 dBm)
DISPERSION:	Continuous from ±0.5 MHz to ±5 MHz from center frequency (1 to 10 MHz span)
BANDWIDTH RESOLUTION:	30 kHz

AUDIO GENERATOR

OPERATING MODE Internal:	Variable frequency generator or 1 kHz tone, or both simultaneously
External and Internal*:	Any external tone(s) plus either or both internal tones simultaneously
VARIABLE TONE Frequency Range:	10 Hz to 9999.9 Hz
Accuracy:	±0.01%
Resolution:	0.1 Hz
Distortion:	10 Hz to 99.9 Hz, 2% maximum 100 Hz to 9999.9 Hz, 0.7% maximum
Output Level:	0-2.5 VRMS into 150Ω load
FIXED TONE Frequency:	1 kHz
Accuracy:	±20 Hz
Distortion:	2% maximum

* RF Generator may be modulated simultaneously from internal and external sources, and internal variable frequency generator may be externally keyed for sequential tone coding.

AUDIO GENERATOR (cont'd)

Output Level:	0-2.5 VRMS into 150Ω load

RECEIVER/MONITOR

FREQUENCY RANGE:	300 kHz to 999.9999 MHz
RESOLUTION:	100 Hz
10 dB SINAD SENSITIVITY:	Typically 2 µV (sensitivity is reduced below 1 MHz)
SELECTIVITY AT 3 dB POINT	
Narrow:	Receiver 15 kHz; detector audio bandwidth is 8 kHz
Mid:	Receiver 150 kHz; detector audio bandwidth is 8 kHz
Wide:	Receiver 150 kHz; detector audio bandwidth is 80 kHz
ADJACENT CHANNEL REJECTION:	Greater than 25 dB at ±25 kHz (typically) Greater than 40 dB at ±50 kHz (typically)
BEAT FREQUENCY OSCILLATOR (BFO):	Variable injection level
BFO LEVEL ACCURACY:	±3 dB, from 2 µV to 5000 µV. BFO is phaselocked to master oscillator
DEMODULATION OUTPUT LEVEL	
AM:	100% = .47 V peak-to-peak nominal
FM:	±10 kHz = 0.65 V peak-to-peak nominal
RECEIVER ANTENNA INPUT PROTECTION:	0.25 watts maximum level without damage

POWER MONTIOR

FREQUENCY RANGE:	1 MHz to 1000.00 MHz
POWER RANGES:	0 to 10 and 0 to 100 watts
ACCURACY 1 to 600 MHz:	±7% of reading plus 3% of full scale
600 to 1000.00 MHz:	±20% of reading plus 3% of full scale
INPUT POWER:	20 watts continuous; 100 watts for 10 seconds
AUTOMATIC MODE SWITCHING:	Automatic changeover from generate to monitor mode at 100 mW (typical) input to TRANS/RCVR Connector

TCXO MASTER OSCILLATOR

ACCURACY:	5×10^{-7} (±0.00005%), 2×10^{-7} (typically) Greater accuracy is attainable with front panel adjustment to WWV.
AGING STABILITY:	2 to 3 PPM during first year; 1 PPM per year thereafter

FREQUENCY ERROR METER MEASUREMENT CAPABILITY

METER SENSITIVITY:	Typically 1.5 μV above 1 MHz (sensitivity is reduced below 1 MHz)
RANGES:	±1.5 kHz, ±5 kHz, ±15 kHz (full scale)
RESOLUTION:	50 Hz (calibration marks at 100 Hz on ±1.5 kHz range)
ZEROING:	Frequency error meter is automatically zeroed every 1.5 seconds during a 3 mSec time period. Auto zeroing may be disabled with AUTO-ZERO/BATT switch.

TONE FREQUENCY MONITORING

MEASUREMENT TECHNIQUES:	Internal tone is selectable with the oscilloscope SWEEP CONTROL to produce a Lissajou oscilloscope pattern from a received signal.

GENERAL

DIMENSIONS:	12.5" Wide, 8" High, 19.5" Deep (31.8 cm W, 20.3 cm H, 49.5 cm D)
WEIGHT:	43 lbs. (19.5 kg)
OPERATING TEMPERATURE RANGE:	32° F to 122° F (0° to 50° C)
POWER REQUIREMENTS:	115/230 V AC 50 to 400 Hz 11 to 28 V DC
TYPICAL DC CURRENTS:	4.3 A at 12 V and 1.85 A at 28 V (With Oscilloscope/Receiver "ON" and Dual Tone Generator/Spectrum Analyzer "OFF".)
TYPICAL POWER CONSUMPTION:	80 W
INTERNAL BATTERY:	12 V DC 5.0 amp-hr

NOTE

- Maximum ON time for measurement of transmitter output using the TRANS/RCVR Connector (7) is:

  10 sec at 100 W, 15% duty cycle
  20 sec at 50 W, 30% duty cycle
  2 min at 30 W, 50% duty cycle

- Specifications and features subject to change without notice.

APPENDIX B: FM/AM-1000S/A STANDARD/OPTIONAL ACCESSORIES

B-1 STANDARD ACCESSORY LIST

Qty.	Description/Function	Model No.	IFR Part No.
1	Allen Wrench, .05" For use in loosening/tightening FM/AM-1000S/A control knobs.	N/A	1025-0000-107
1	Antenna For attachment to ANT INPUT Connector (44) when monitoring "off-the-air" signals.	N/A	1201-7616-500
1	AC Power Cord For use in powering FM/AM-1000S/A from standard AC power sources.	N/A	6041-2326-602
1	DC Power Cord (w/cigar lighter adaptor) For use in powering FM/AM-1000S/A from 12 volt DC power sources.	N/A	6041-2326-601
1	90° Angle BNC Connector (Male to Female) For use in pointing antenna skyward when FM/AM-1000S/A is set into a horizontal operating position.	N/A	2113-0000-013
1	Fuse, 1¼ Ampere, SLO BLO Replacement fuse for FM/AM-1000S/A AC line fuse.	N/A	5106-0000-005
2	Fuse, 7½ Ampere Replacement fuses for FM/AM-1000S/A battery or external DC fuses.	N/A	5106-0000-009

B-2 OPTIONAL ACCESSORY LIST

Qty.	Description/Function	Model No.	IFR Part No.
1	Canvas Cover/Carrying Case FM/AM-1000S/A protective carrying case with three built-in compartments for accessories.	CS-114	1412-2380-700

B-2 OPTIONAL ACCESSORY LIST (cont'd)

Qty.	Description/Function	Model No.	IFR Part No.
1	MM-100 Multimeter w/PB-114 Probe Self contained 8 function multimeter incorporated into FM/AM-1000S/A lid; includes "x 1" and "x 10" test probe (600 V RMS, 800 VDC)	MM-100	9001-2381-600
1	Fuse, 1/32 Ampere Replacement fuse for MM-100 Multimeter ohms circuit	N/A	5106-4500-031
1	10 dB BNC Attenuator, 1 Watt	AT-10	2901-0401-010
1	20 dB BNC Attenuator, 1 Watt	AT-20	2901-0401-020
1	30 dB BNC Attenuator, 2 Watt	AT-30	2901-0402-030
1	10 dB BNC Type N Attenuator, 150 Watt	AT-4010	2901-0680-010
1	10 dB BNC Type N Attenuator, 150 Watt, w/coax cable assy.	AT-4010A	7005-2381-100
1	Coax Assembly, Flexible, 150 Watt For use in connecting AT-4010 150 Watt Attenuator to FM/AM-1000S/A	CA-114	6053-0450-600
1	Antenna (Telescopic)	ANT-2	1201-0909-900

APPENDIX C: dBm TO MICROVOLT CONVERSION CHART

dBm	μV	dBm	μV	dBm	μV
0	224,000	-47	1,000	-94	4.47
-1	200,000	-48	891	-95	3.99
-2	178,000	-49	795	-96	3.55
-3	159,000	-50	709	-97	3.17
-4	141,000	-51	633	-98	2.82
-5	126,000	-52	563	-99	2.52
-6	112,000	-53	501	-100	2.24
-7	100,000	-54	447	-101	2.00
-8	89,100	-55	399	-102	1.78
-9	79,500	-56	355	-103	1.59
-10	70,900	-57	317	-104	1.41
-11	63,300	-58	282	-105	1.26
-12	56,300	-59	252	-106	1.12
-13	50,100	-60	224	-107	1.00
-14	44,700	-61	200	-108	0.891
-15	39,900	-62	178	-109	0.795
-16	35,500	-63	159	-110	0.709
-17	31,700	-64	141	-111	0.633
-18	28,200	-65	126	-112	0.563
-19	25,200	-66	112	-113	0.501
-20	22,400	-67	100	-114	0.447
-21	20,000	-68	89.1	-115	0.399
-22	17,800	-69	79.5	-116	0.355
-23	15,900	-70	70.9	-117	0.317
-24	14,100	-71	63.3	-118	0.282
-25	12,600	-72	56.3	-119	0.252
-26	11,200	-73	50.1	-120	0.224
-27	10,000	-74	44.7	-121	0.200
-28	8,900	-75	39.9	-122	0.178
-29	7,950	-76	35.5	-123	0.159
-30	7,090	-77	31.7	-124	0.141
-31	6,330	-78	28.2	-125	0.126
-32	5,630	-79	25.2	-126	0.112
-33	5,010	-80	22.4	-127	0.100
-34	4,470	-81	20.0	-128	0.0891
-35	3,990	-82	17.8	-129	0.0795
-36	3,550	-83	15.9	-130	0.0709
-37	3,170	-84	14.1	-131	0.0633
-38	2,820	-85	12.6	-132	0.0563
-39	2,520	-86	11.2	-133	0.0501
-40	2,240	-87	10.0	-134	0.0447
-41	2,000	-88	8.91	-135	0.0399
-42	1,780	-89	7.95	-136	0.0355
-43	1,590	-90	7.09	-137	0.0317
-44	1,410	-91	6.33	-138	0.0282
-45	1,260	-92	5.63	-139	0.0252
-46	1,120	-93	5.01	-140	0.0224

APPENDIX D: REPACKING FOR SHIPMENT

D-1 SHIPPING INFORMATION

IFR test sets returned to factory for calibration, service or repair must be repackaged and shipped subject to the following conditions:

- Do not return any products to factory without first receiving authorization from IFR Customer Service Department.

  CONTACT:

  Customer Service Dept.
  IFR, Inc.
  10200 West York Street
  Wichita, Kansas 67215

  Telephone: (800)-835-2350
  TWX: 910-741-6952

- All test sets must be tagged with:

  a. Owner's indentification and address.
  b. Nature of service or repair required.
  c. Model No.
  d. Serial No.

- Sets must be repackaged in original shipping containers using IFR packing models. If original shipping containers and materials are not available, contact IFR Customer Service Dept. for shipping instructions.

- All freight costs on non-warranty shipments are assumed by customer. (See "Warranty Packet" for freight charge policy on warranty claims.)

D-2 REPACKING PROCEDURE (Reference - Figure D-1):

1. Make sure bottom packing mold is seated on floor of shipping container.

2. Carefully wrap test set with polyethylene sheeting to protect finish.

3. Place test set into shipping container, making sure set is securely seated in bottom packing mold.

4. Place top packing mold over top of set and press down until mold rests solidly on bottom packing mold.

5. Close shipping container lids and seal with shipping tape or an industrial stapler. Tie all sides of container with break resistant rope, twine or equivalent.

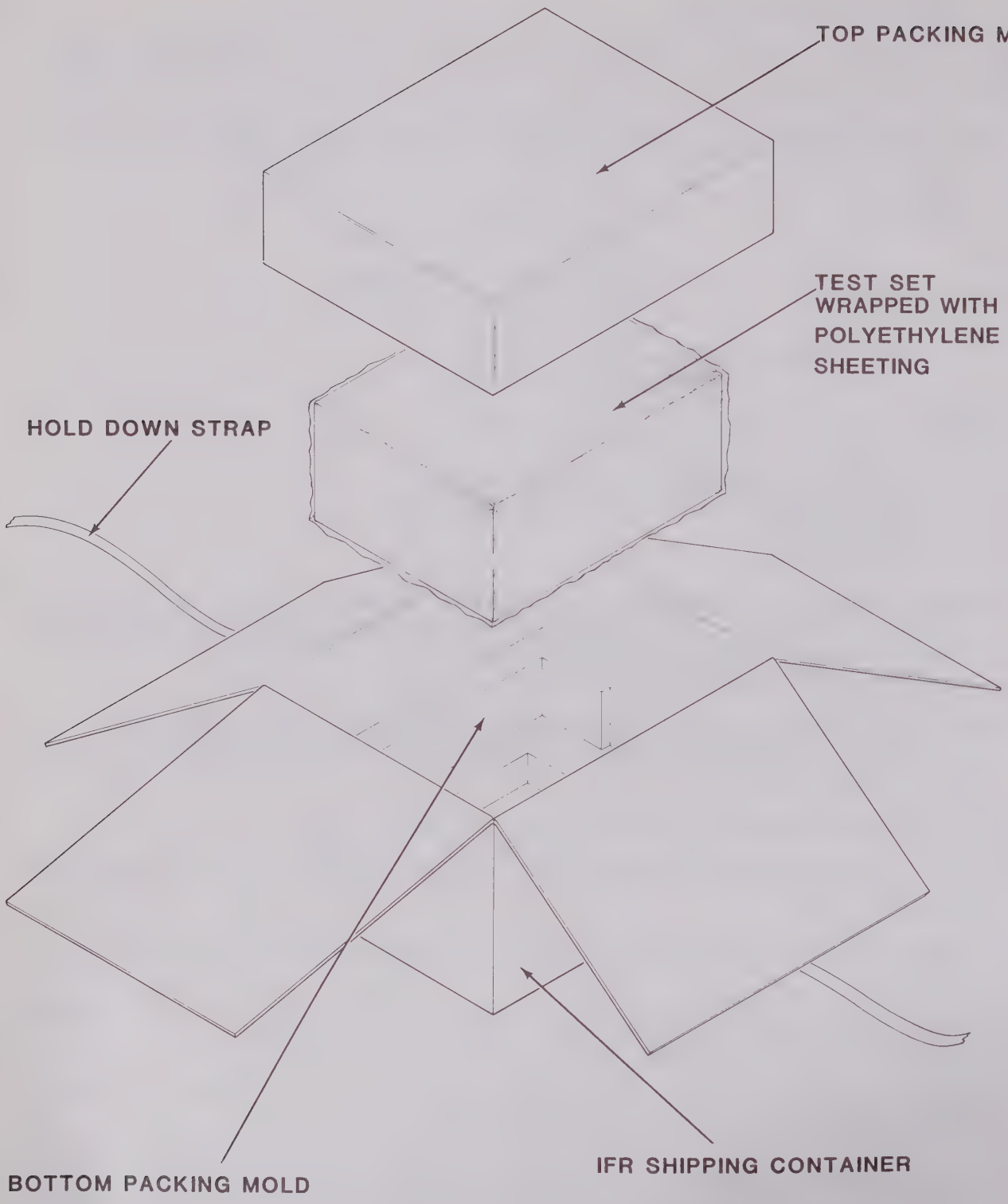


FIGURE D-1 REPACKING FOR SHIPMENT

APPENDIX E: SWEEP GENERATOR/TRACKING OSCILLOSCOPE OPERATION
(Viewing frequency response display directly on oscilloscope w/o use of detector)

When maximum frequency to be swept is below 1 MHz, operator may view frequency response curve directly on FM/AM-1000S/A oscilloscope, without use of a detector. If this is done, the frequency response display will appear slightly different from the display obtained when using a detector. The examples below provide comparisons between the frequency response displays using the two different viewing methods. This information should be useful in interpreting the significant characteristrics of the displays.

TEST SET-UP DIAGRAM: To view frequency response envelope directly on oscilloscope (w/o use of detector), equipment set-up must be made as shown:

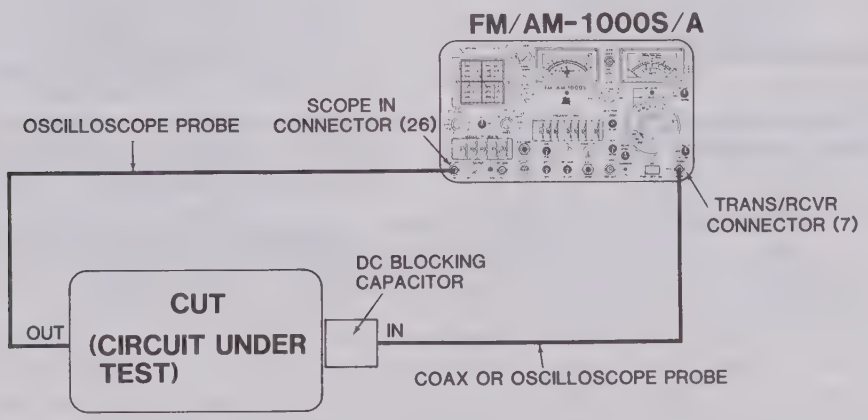
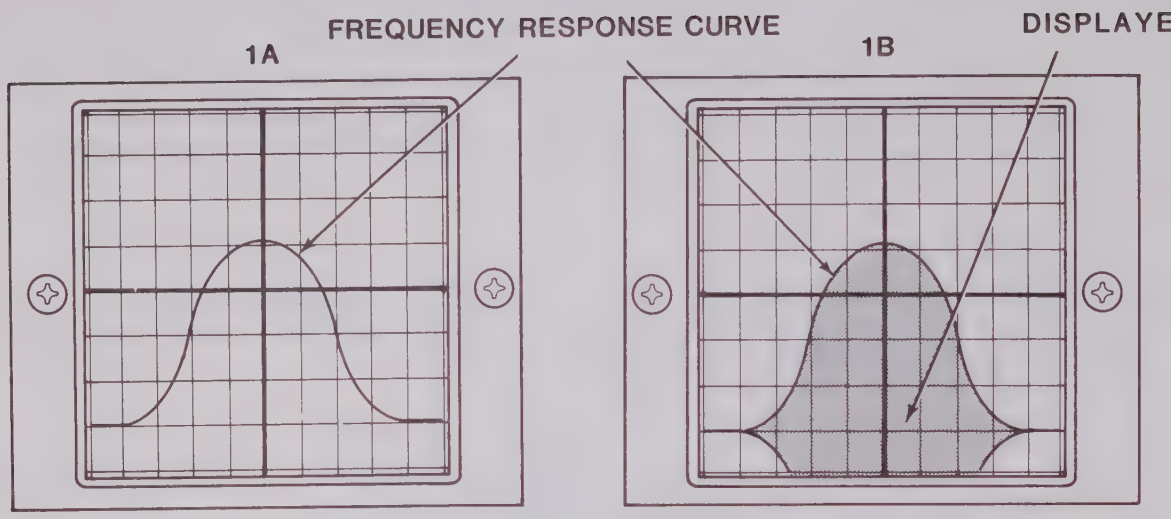


FIGURE E-1 TEST SET-UP DIAGRAM FOR VIEWING FREQUENCY RESPONSE CURVE DIRECTLY ON FM/AM-1000S/A OSCILLOSCOPE

TEST SET-UP
DIAGRAM: (cont'd)

EXAMPLES:



TYPICAL FREQUENCY RESPONSE CURVE (USING POSITIVE DETECTOR)

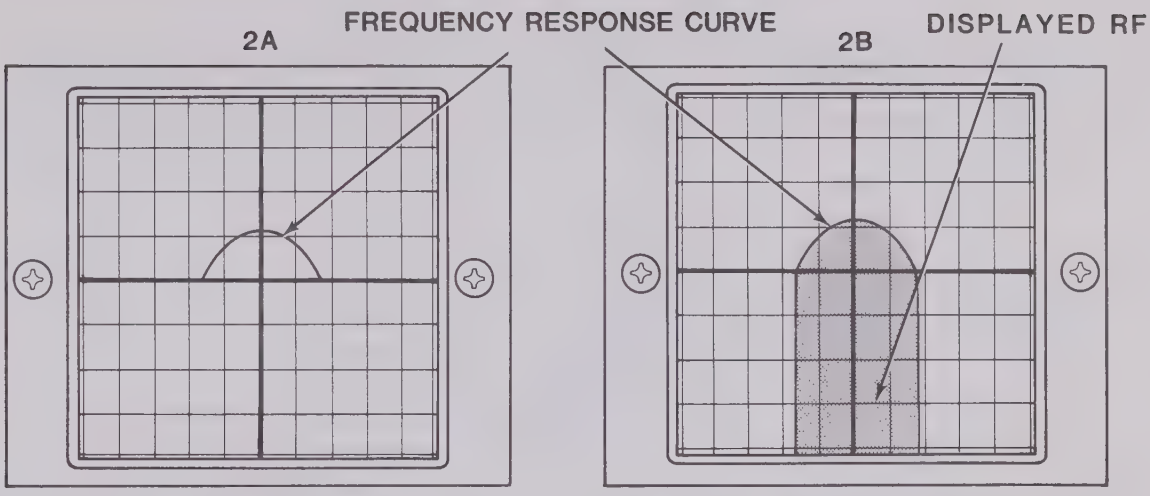
TYPICAL FREQUENCY RESPONSE CURVE AS VIEWED DIRECTLY ON OSCILLOSCOPE (W/O DETECTOR)

FIGURE E-2 FREQUENCY RESPONSE CURVE COMPARISON (AS VIEWED ON OSCILLOSCOPE WITH AND WITHOUT USE OF DETECTOR

Note similarities between examples 1A & 1B above. When viewing frequency response curve directly on oscilloscope (w/o detector), operator should be concerned with response curve only; any displayed RF should be disregarded.

TEST SET-UP
DIAGRAM: (cont'd)

EXAMPLES:



TYPICAL FREQUENCY RESPONSE CURVE AFTER REDUCING FREQUENCY DEVIATION (USING POSITIVE DETECTOR AND NARROWER FREQUENCY SPAN)

TYPICAL FREQUENCY RESPONSE CURVE AFTER REDUCING FREQUENCY DEVIATION (NARROWER FREQUENCY SPAN) AS VIEWED DIRECTLY ON OSCILLOSCOPE

FIGURE E-3 FREQUENCY RESPONSE CURVE COMPARISON (AS VIEWED ON OSCILLOSCOPE WITH AND WITHOUT USE OF DETECTOR)

Note similarities between examples 2A & 2B above. When viewing frequency response curve directly on oscilloscope (w/o detector), operator should locate legs of frequency response curve and points at which they intersect major horizontal axes.

APPENDIX F: PINOUT/CONTACT ASSIGNMENTS FOR EXTERNAL ACCESSORY & EXTERNAL MODULATION CONNECTORS

F-1 PINOUT TABLE FOR EXTERNAL ACCESSORY CONNECTOR

The table below provides pin assignments for the EXT ACC Connector (20) located on front panel of the FM/AM-1000S/A. This connector provides power and signal sources for external accessory equipment used with the FM/AM-1000S/A.

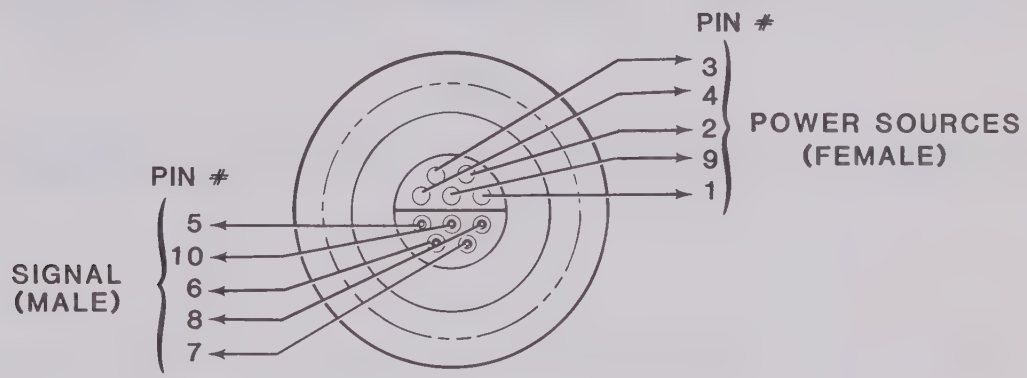


FIGURE F-1 PINOUTS FOR EXTERNAL ACCESSORY CONNECTOR (FRONT VIEW)

CONNECTOR PIN ASSIGNMENTS			
Pin No.	Power Source	Pin No.	Signals
1	+12 V	5	External Modulation
2	+11 V	6	Tone Keying*
3	+5 V	7	Generator Keying**
4	-12 V	8	Demodulated Signal Out
9	Ground	10	Signal Ground

* Open enables variable tone generator; short to ground disables variable tone generator.
** Short to ground places FM/AM-1000S/A into generate mode.

F-2 CONTACT ASSIGNMENTS FOR EXTERNAL MODULATION CONNECTOR

The illustration below provides contact assignments for the mating EXT MOD Connector (3 conductor ¼" phone plug) used with the EXT MOD Connector (21) on front panel of FM/AM-1000S/A. This connector provides an external modulation input signal and keying for the FM/AM-1000S/A Variable Tone generator. (See External Modulation Specifications in Appendix A.)

NOTE

- Keying affects only the variable tone generator (not the 1 kHz fixed tone generator or external modulation input.)

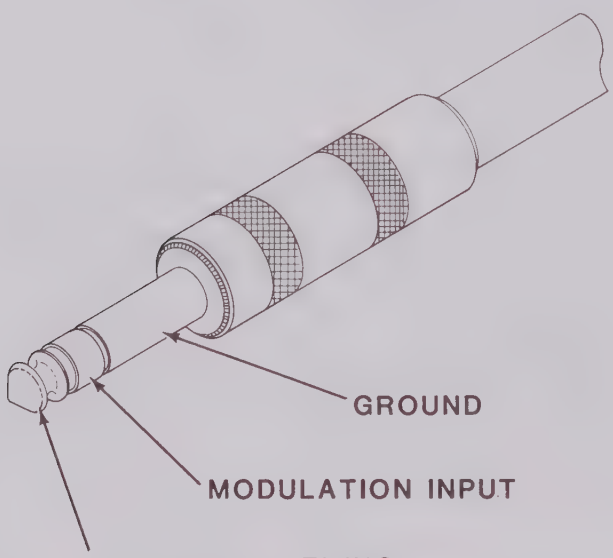


FIGURE F-2 CONTACT ASSIGNMENTS FOR EXTERNAL MODULATION CONNECTOR

APPENDIX G: HOW TO CONSTRUCT AN RF PICKUP ("SNIFFER") CABLE

Described below are instructions for constructing an RF pickup cable (or "sniffer" cable), which is a required test accessory for operating procedures 4-8-2 and 4-8-2A titled "OSCILLATOR FREQUENCY MEASUREMENT".

MATERIALS REQUIRED:

3' (Minimum) length of RG316/U or RG58/U coax cable w/BNC female connector on one end.
Electrical Tape
Knife
Wire Strippers
Scissors
Soldering Iron
Solder

STEP PROCEDURE

1. Prepare length of flexible coax cable as shown in Figure G-1 below:

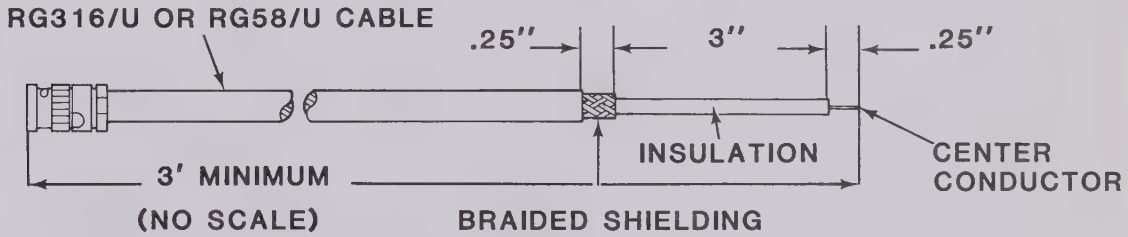


FIGURE G-1 FLEXIBLE COAX CABLE PREPARATION

2. Bend coax cable into loop as shown in Figure G-2 below and solder center conductor to braided shielding.

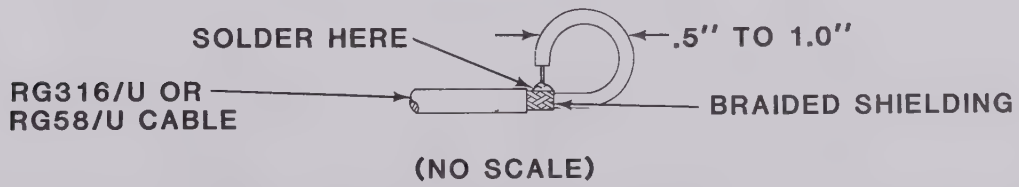


FIGURE G-2 SOLDERING CABLE CENTER CONDUCTOR TO BRAIDED SHIELDING

3. Wrap soldered joint completely with electrical tape, making sure no portion of braided shielding, solder or center conductor is exposed. RF pickup cable is now ready for use.

APPENDIX H: ABBREVIATIONS & SYMBOLS

Defined below are abbreviations and symbols commonly used throughout the FM/AM-1000S/A Operation Manual text:

A	- Ampere
AC	- Alternating Current
AM	- Amplitude Modulation
amp hr	- ampere hour
BATT	- Battery
BFO	- Beat Frequency Oscillator
BNC	- Bayonet-Coupled Quick Disconnect (Industry standard coax connector)
°C	- Degrees Celsius
CAL	- Calibrated
ccw	- counterclockwise
cm	- centimeter
cw	- clockwise
CRT	- Cathode Ray Tube
CUT	- Circuit Under Test
dB	- decibels
dBm	- decibels per 1 milliwatt
DC	- Direct Current
EXT ACC	- External Accessory
EXT MOD	- External Modulation
EXT V/DIV	- External Volts per Division
°F	- Degrees Fahrenheit
FM	- Frequency Modulation
GEN	- Generator
HI LVL	- High Level
HORIZ	- Horizontal
Hz	- Hertz
IC	- Integrated Circuit
IF	- Intermediate Frequency
INT MOD	- Internal Modulation
Kg	- Kilogram
kHz	- kilohertz
lbs	- pounds
min	- minute(s)
MHz	- Megahertz
µs	- microsecond
µV	- microvolt
ms	- millisecond
msec	- millisecond
mV	- millivolt
mW	- milliwatt
N/A	- Not Applicable
No.	- Number
NORM	- Normal
PLL	- Phase-Locked Loop

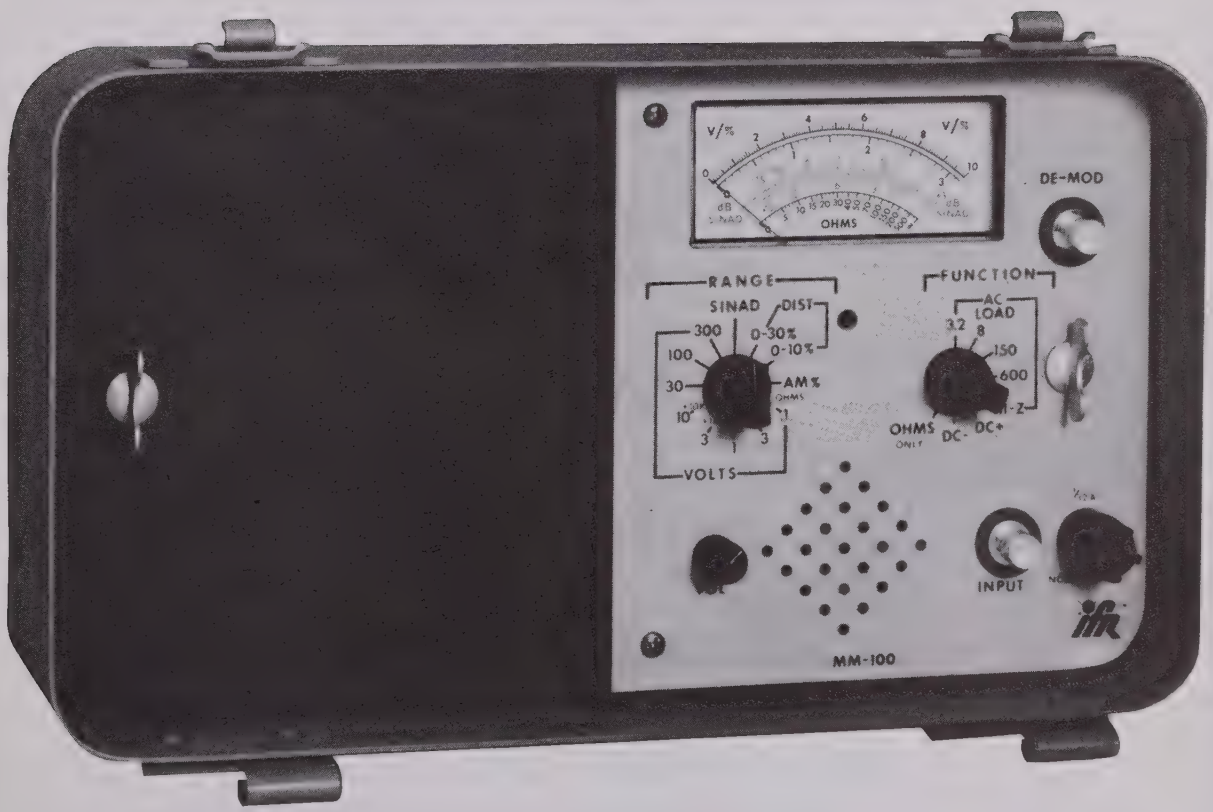
PPM	- Pulse Per Minute
psi	- pounds per square inch
PWR	- Power
RCVR	- Receiver
RF	- Radio Frequency
RFi	- Radio Frequency Interferance
RMS	- Root Mean Square
scope	- oscilloscope
sec	- second(s)
SIG	- Signal
SINAD	- Signal plus Noise and Distortion
TCXO	- Temperature Compensated Crystal Oscillator
TRANS	- Transmitter
typ.	- typical
UUT	- Unit Under Test
V	- Volts
Vp	- Volts Peak
Vp-p	- Volts Peak-to-Peak
Vv	- Volts Valley
VAC	- Volts Alternating Current
VDC	- Volts Direct Current
VOL	- Volume
V RMS	- Volts Root Mean Square
W	- Watts

MM-100 - Designation for test procedures which can be more easily performed using MM-100 Multi-Meter option, if FM/AM-1000S/A is so equipped.

OPERATION MANUAL

MM-100

MULTI-METER



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Manual Part Number: 1002-2381-400
Date Printed: May 1981

WARNING:

HIGH VOLTAGE EQUIPMENT

THIS EQUIPMENT CONTAINS CERTAIN CIRCUITS AND/OR COMPONENTS OF EXTREMELY HIGH VOLTAGE POTENTIALS, CAPABLE OF CAUSING SERIOUS BODILY INJURY OR DEATH. WHEN PERFORMING ANY OF THE PROCEDURES CONTAINED IN THIS MANUAL, HEED ALL APPLICABLE SAFETY PRECAUTIONS.

RESCUE OF SHOCK VICTIMS

1. DO NOT ATTEMPT TO PULL OR GRAB THE VICTIM
2. IF POSSIBLE, TURN OFF THE ELECTRICAL POWER.
3. IF YOU CANNOT TURN OFF ELECTRICAL POWER, PUSH, PULL OR LIFT THE VICTIM TO SAFETY USING A WOODEN POLE, A ROPE OR SOME OTHER DRY INSULATING MATERIAL.

FIRST AID

1. AS SOON AS VICTIM IS FREE OF CONTACT WITH SOURCE OF ELECTRICAL SHOCK, MOVE VICTIM A SHORT DISTANCE AWAY FROM SHOCK HAZARD.
2. SEND FOR DOCTOR AND/OR AMBULANCE.
3. KEEP VICTIM WARM, QUIET AND FLAT ON HIS/HER BACK.
4. IF BREATHING HAS STOPPED, ADMINISTER ARTIFICAL RESUSCITATION. STOP ALL SERIOUS BLEEDING.

LIST OF EFFECTIVE PAGES

The portion of text affected by the changes is indicated by a vertical line in the outer margin of the page. Changes to illustrations are indicated by revision letter. Changes to wiring diagrams are indicated by shaded areas.

Date of issue for original and changed pages are:

Original ..... 0 ..... May 1, 1981
Change No. ..... 1 ..... Sept. 1, 1981

TOTAL NUMBER OF PAGES IN THIS MANUAL IS 46 CONSISTING OF FOLLOWING:

Page No.	Change No.
Title Page	0
*Copyright	1
*Warning	1
*A	1
B Blank	0
i	0
ii Blank	0
iii thru v	0
vi Blank	0
1-1	0
1-2	0
*2-1	1
2-2	0
3-1	0
*3-2 thru 3-4	1
3-5 thru 3-6	0
4-1 thru 4-5	0
4-6 Blank	0
4-7 thru 4-11	0
4-12 Blank	0
4-13 thru 4-14	0
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4-16	0
*4-17	1
4-18	0
*4-19	1
4-20 thru 4-21	0
4-22 Blank	0
*4-23	1
4-24 thru 4-25	0
4-26 Blank	0
4-27 thru 4-28	0

Manual pages affected by current change are denoted by asterisk.

PREFACE

This manual provides descriptive information, tabular data, illustrations and sample test procedures for the operation of the optional accessory MM-100 Multi-Meter. The MM-100 Multi-Meter is designed to be used with FM/AM-1000S Communications Service Monitor serial numbers 1506 thru 1510, 1561 thru 1565, 1616 and on and with FM/AM-1000A Communications Service Monitor serial numbers 1793 and on. The MM-100 complements the Communications Service Monitor by reducing the number of test meters required to provide the operator with signal values of SINAD, distortion, etc. Throughout this manual the text will refer to two models of the Communications Service Monitor: FM/AM-1000S and FM/AM-1000A. Typical examples of references used in the text:

"Communications Service Monitor" is used to express a statement or information that is applicable to either model.

"FM/AM-1000S or FM/AM-1000A", when used together, is used on specific statements.

When only one Communications Service Monitor model is referenced, this indicates that the text is suitable for only that particular model.

The FM/AM-1000S is illustrated in figures throughout the manual when information is suitable for both Communications Service Monitor models.

Section 1 thru Section 4 provide the following operational information:

Section 1	Provides general description of the MM-100 Multi-Meter.
Section 2	Provides the identification of MM-100 including safety precautions and meter mode select switch positions table.
Section 3	Provides a description of controls, connectors and indicators.
Section 4	Provides instruction, using examples, on how to set-up the MM-100 for particular test procedures.

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SECTION 1 - INTRODUCTION

1-1 GENERAL

This section provides general description of MM-100 Multi-Meter. The MM-100 Multi-Meter is an optional accessory assembled into the Communications Service Monitor lid assembly. The optional accessory MM-100 Multi-Meter is suitable for use with FM/AM-1000S Communications Service Monitor serial numbers 1506 thru 1510, 1561 thru 1565, 1616 and on and with FM/AM-1000A Communications Service Monitor serial numbers 1793 and on. FM/AM-1000S units and FM/AM-1000A units with serial numbers other than those listed do not have an EXT ACC (external accessory) Connector.

1-2 DESCRIPTION

The MM-100 Multi-Meter design functions include: AC Voltmeter, DC Voltmeter, Ohmmeter, SINAD Meter, Distortion Meter and Audio Monitor. Electrically, the MM-100 Multi-Meter receives operating power from the Communications Service Monitor thru the interconnect cable assembly. Mechanically, the MM-100 Multi-Meter installs in the Communications Service Monitor lid assembly and the lid assembly is attached by two hinges (slide type).

1-2-1 SINGLE ANALOG METER

The single analog meter is a dc milliammeter window mount type. The meter controls are two rotary selector switches used to select a function and a range applicable to perform a specific test or check.

Five individual scales are displayed in the viewing area (meter face) of the meter (starting with the lower scale and identifying each scale in sequence thru the upper scale):

Ohm Scale - A zero to infinity nonlinear ohm meter scale with black numeral display.

SINAD Scale - A twenty to zero nonlinear SINAD meter scale with blue numeral display.

dB Scale - A -15 to +3 nonlinear meter scale with red numeral display.

V/% Scale - The lower scale is zero to three linear meter scale and the upper scale is zero to ten linear meter scale. Both meter scales have black numeral display.

1-2-2 ROTARY SELECT SWITCHES

Two rotary select switches are used to select a mode in which the meter is to operate. One rotary switch is identified as RANGE Control and the other switch is identified as FUNCTION Control. The rotary select switches utilize stops to limit switch rotation. The RANGE Control will rotate from 4 o'clock position thru 12 o'clock position to 3 o'clock position and back. The FUNCTION Control will rotate from 12 o'clock position thru 7 o'clock and back.

1-2-3 AUDIO MONITOR

A speaker with an independent volume control is incorporated in the MM-100 Multi-Meter to monitor audio signals. The speaker is active in all meter modes except OHMS mode. Use of the speaker shall not affect the accuracy of measurement functions.

1-2-4 FUSE

The fuse holder located on the front panel, provides easy access for replacement of the 1/32 ampere fuse. The fuse protects the ohms measuring circuitry. For spare fuse information, refer to applicable optional accessory list in Appendix B of FM/AM-1000S or FM/AM-1000A Operation Manual.

1-2-5 CABLES AND PROBE

Two cable assemblies associated with the MM-100 Multi-Meter are the interconnect cable and the test probe. The interconnect cable, soldered to the printed circuit board at one end, routes thru the side of the multi-meter assembly into the lid assembly storage area. The quick disconnect convenience connector at the other end of the interconnect power cable mates with the EXT ACC connector on the front panel of Communications Service Monitor. The probe assembly that is used for MM-100 Multi-Meter is an optional accessory; refer to applicable optional accessory in Appendix B of FM/AM-1000S or FM/AM-1000A Operation Manual for additional information.

SECTION 2 - INSTALLATION

2-1 GENERAL

This section contains safety precautions, equipment inspection procedures and identification of the optional accessory MM-100 Multi-Meter test equipment. For additional information on optional accessories, refer to applicable FM/AM-1000S or FM/AM-1000A Operation Manual, Appendix B.

2-1-1 SAFETY PRECAUTIONS

Listed below are several important safety precautions that shall be observed during all phases of system installation and operation. IFR, INC. assumes no liability for customer's failure to comply with any of the safety precautions outlined in this manual.

- Comply with installation and operating instructions.
- To minimize shock hazard, use approved electrical grounding methods. Do not adapt a three-prong connector to a two-prong receptacle.
- Observe warning and caution labels.

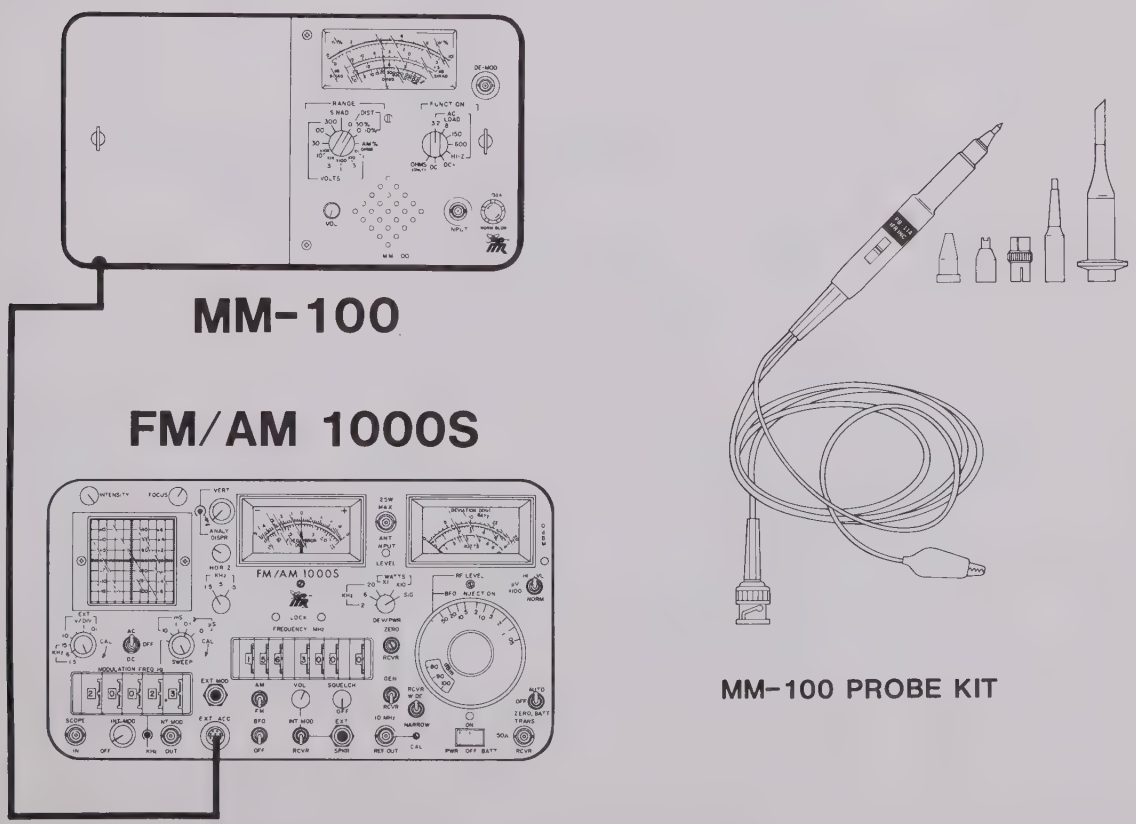


FIGURE 2-1 MM-100 MULTI-METER TEST EQUIPTMENT

2-1-2 EQUIPMENT INSPECTION

All IFR MM-100 Multi-Meters are inspected for material defects and are subjected to a performance check prior to leaving the factory. Follow the applicable inspection, damage claim, warranty and shipping procedures as described in FM/AM-1000S or FM/AM-1000A Operation Manual.

SECTION 3 - DESCRIPTION OF CONTROLS, CONNECTORS AND INDICATORS

3-1 MM-100 FRONT PANEL

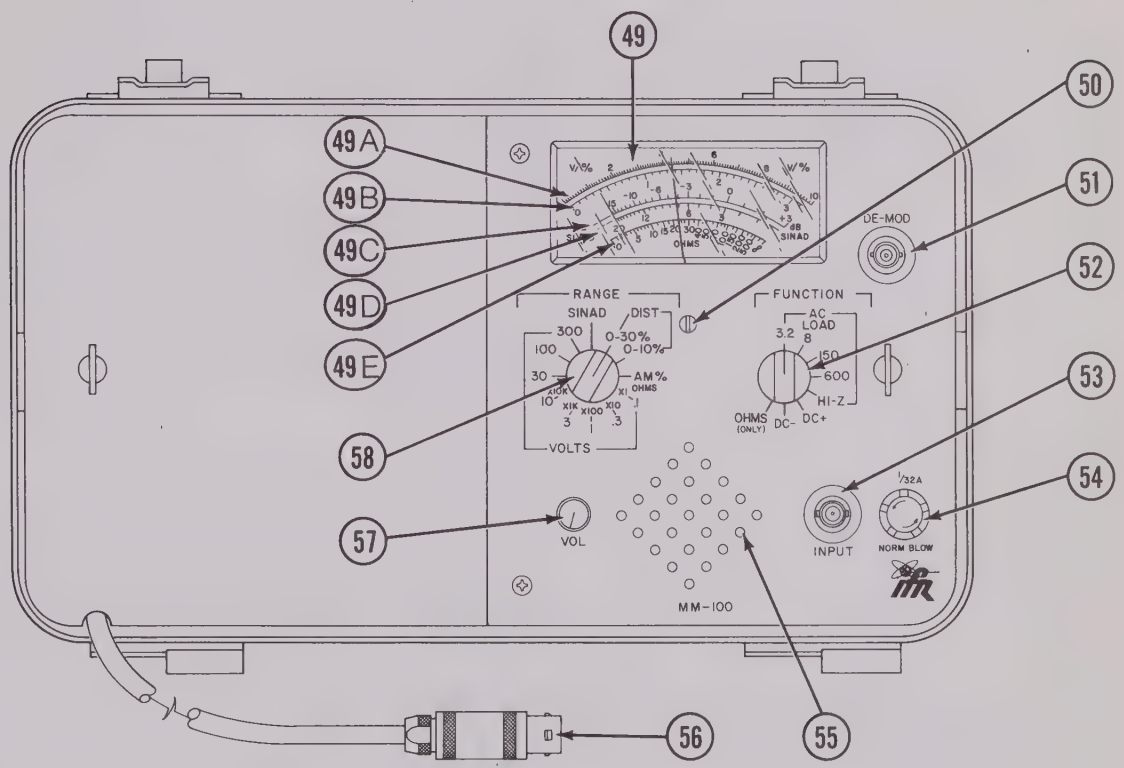


FIGURE 3-1 MM-100 FRONT PANEL

49. METER Display
    - 49A. V/% (0-10) Scale
    - 49B. V/% (0-3) Scale
    - 49C. dB Scale
    - 49D. SINAD Scale
    - 49E. OHMS Scale
50. METER Zero Adjustment
51. DE-MOD Connector
52. FUNCTION Control
53. INPUT Connector
54. NORM BLOW Fuse
55. Audio Monitor
56. MM-100 Interconnect Power Cable
57. VOL Control
58. RANGE Control

49. METER Display — A dc milliammeter with face (viewing area) having five scales for measuring voltage, distortion, SINAD, resistance, % A.M. modulation and a reference scale for dB ratios.

50. METER Zero Adjustment — An adjusting screw used to set the meter at zero position (with power off).

51. DE-MOD Connector — A BNC Connector which presents demodulated audio output of the FM/AM-1000S.

52. FUNCTION Control — A multi-function rotary select switch.

a. "OHMS" position selects function for measuring resistance. MM-100 audio monitoring function is disabled. Select one of five ohm ranges on RANGE Control (58); this will enable the meter needle to indicate the resistance at INPUT Connector (53) on the meter's ohm scale.

b. "DC+" and "DC-" positions select function for measuring positive and negative dc voltage. Select one of eight voltage ranges on RANGE Control (58); this will enable the meter needle to indicate dc voltage input from INPUT Connector (53) on the meter's V/% scales (49A and 49B).

c. The five AC/INPUT Z function positions (12 o'clock position thru 4 o'clock position) select impedance load for measuring audio signals and ac voltages.

(1) INPUT Z positions "3.2, 8, 150, 600, and HI-Z (1 Meg OHM)" select corresponding audio impedance load and places the INPUT Z load in the meter measuring circuit. Select one of eight voltage ranges on RANGE Control (58); this will enable the meter needle to indicate audio voltage input from Connector (53) on the meter's V/% scales (49A and 49B).

(2) A dB scale is provided for referencing dB measurements during AC operation.

53. INPUT Connector

A BNC connector identified as INPUT Connector provides a convenient connection to attach a test probe. All functions except AM % modulation input thru this connector.

54. NORM BLOW Fuse

A 1/32 ampere fuse is placed in ohms measuring circuit to protect the ohms measuring circuit.

55. Audio Monitor

The speaker provides an aural monitor for audio signals received through the INPUT Connector, except in the OHMS position.

57. VOL Control

Volume control selects listening level of monitored audio.

58. RANGE Control

A multi-function rotary select switch that selects a meter function or selects a meter range. The meter function positions are "SINAD, DIST 0-30%, DIST 0-10%, and AM%."

a. "SINAD" position selects meter function for measuring SINAD ratio. Select an INPUT Z, determined from unit under test, on the FUNCTION Control (52); this will enable the meter needle to indicate the ratio input from INPUT Connector (53) on the meter's SINAD scale.

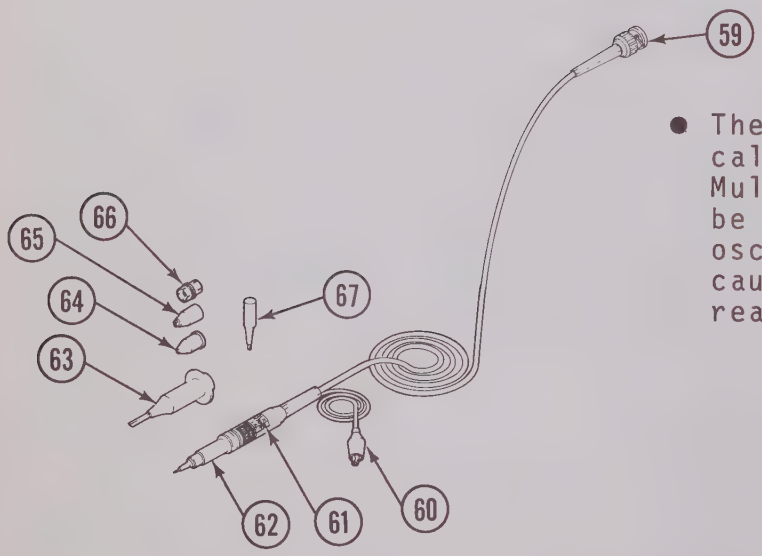
b. DIST 0-30% and DIST 0-10% positions select meter function for measuring signal distortion. Select an INPUT Z, determined from unit under test, on the FUNCTION Control (52); this will enable meter needle to indicate signal distortion input from INPUT Connector (53) on the meter's V/% scales (49A).

58. RANGE Control (cont'd)

c. "AM%" position selects meter function for measuring percentage of amplitude modulation. FUNCTION Control (52) is disabled. Input to the meter is thru the cable that mates with EXT ACC connector on the front panel of the Communications Service Monitor, this will enable meter needle to indicate percentage of amplitude modulation on the meter's V/% scale (49A and 49B).

d. OHMS range positions "X1, X10, X100, X1K and X10K" (4 o'clock position thru 8 o'clock position) select corresponding resistive loads to place multipliers in the resistance measuring circuit. Refer to FUNCTION Control (52) for additional information for measuring resistance.

e. VOLTS range positions ".1, .3, 1, 3, 10, 30, 100, and 300." (4 o'clock position thru 11 o'clock position) select corresponding meter full scale range, for measuring dc volts, ac volts and audio signals. Refer to FUNCTION Control (52) for additional information.



NOTE

- The MM-100 Probe is factory calibrated for use with MM-100 Multi-Meter. No attempt should be made to adjust probe for oscilloscope use as this will cause erroneous MM-100 AC meter readings.

FIGURE 3-2 MM-100 PROBE AND PROBE KIT

59. Probe BNC Connector
60. Probe Ground Clip
61. Probe Range Switch
62. Probe
63. Probe Clip
64. Insulator
65. Insulator
66. BNC Adaptor
67. Screwdriver

3-2 FM/AM-1000S FRONT PANEL

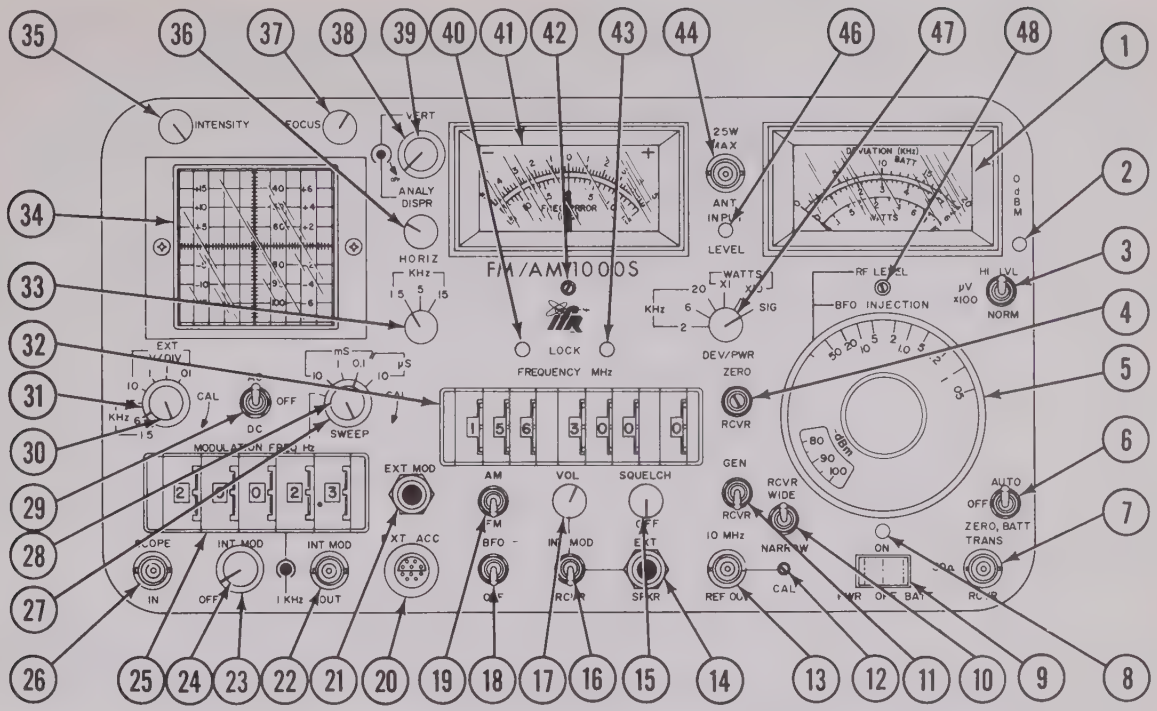


FIGURE 3-3 FM/AM-1000S FRONT PANEL

1. DEVIATION/WATTS Meter
2. O dBm Lamp
3. HI LVL/µV X 100/NORM Switch
4. ZERO RCVR Adjustment
5. RF LEVEL/BFO INJECTION Dial
6. AUTO/OFF/ZERO, BATT Switch
7. TRANS/RCVR Connector
8. Power ON Lamp
9. PWR/OFF/BATT Switch
10. RCVR WIDE/MID/NARROW Switch
11. GEN/RCVR Switch
12. 10 MHz CAL Adjustment
13. 10 MHz REF OUT Connector
14. EXT SPKR Connector
15. SQUELCH Control
16. INT MOD/RCVR Switch
17. VOL Control
18. BFO/OFF Switch
19. AM/FM Switch
20. EXT ACC Connector
21. EXT MOD Connector
22. INT MOD OUT Connector
23. INT MOD Control
24. 1 kHz INT MOD Control
25. MODULATION FREQ Hz Thumbwheels
26. SCOPE IN Connector
27. SWEEP Control
28. SWEEP Vernier Control
29. AC/OFF/DC Switch
30. EXT V/DIV Vernier Control
31. EXT V/DIV Control
32. FREQUENCY MHz Thumbwheels
33. 1.5/5/15 kHz Control
34. CRT Display
35. INTENSITY Control
36. HORIZ Control
37. FOCUS Control
38. VERT Control
39. ANALY DISPR Control
40. High Frequency LOCK Lamp
41. FREQ ERROR Meter
42. FREQ ERROR Meter Zero Adjustment
43. Low Frequency LOCK Lamp
44. ANT INPUT Connector
45. NOT USED
46. INPUT LEVEL Lamp
47. DEV/PWR Control
48. DEVIATION/WATTS Meter Zero Adjustment

3-3 INTERCONNECT POWER CABLE

MM-100 interconnect power cable stows in the lid assembly storage compartment. Access to the interconnect cable is by removal of the accessory storage cover. The accessory storage cover can be installed with the interconnect cable stowed or extended. For the MM-100 Multi-Meter to be operational, the interconnect power cable connector shall be mated with EXT ACC connector on the front panel of an operational Communications Service Monitor.

SECTION 4 - OPERATION

4-1 GENERAL

This section provides operating instructions relating to major function of the MM-100. Included in the introductory paragraphs are recommended operating parameters of the MM-100, the initial switch position setting beginning each procedure and a feature for checking semiconductors. All nomenclature and numerals associated with MM-100 Test Set-up switches and controls are referenced to Section 3.

For purposes of clarity and ease of understanding, instructions are presented as individual test procedures. Reference to FM/AM-1000S or FM/AM-1000A Operating Manual for test procedures is made to prevent duplication. Each test procedure contains the following common headings:

4-5-1	Procedure Number
TEST PROCEDURE:	Name of procedure to be performed.
TEST OBJECTIVE:	Purpose or intent of procedure; if name of TEST PROCEDURE itself implies test objective, this heading will contain N/A (not applicable).
SPECIAL ACCESSORY EQUIPMENT REQ'D:	List of any special accessory test equipment required to complete procedure, beyond MM-100 and UUT.
TEST SET-UP DIAGRAM:	A diagramatic aid to operator in connecting MM-100 to UUT.

4-1-1 OPERATING PRECAUTIONS

Listed below are several important operating precautions that shall be observed during operating procedures. Failure to comply with the precautions will damage the MM-100 Multi-Meter or the MM-100 Probe.

1. Do not slam or drop the Communications Service Monitor lid assembly.
2. Do not allow the MM-100 probe to contact live circuits or charged capacitors when the FUNCTION Control (52) is set to "OHMS" position.
3. Do not attempt to measure AC voltage above 600 V RMS.
4. Do not attempt to measure DC voltage above 800 VDC.
5. Do not exceed AC load power limitation.

4-2 ZERO METER ADJUSTMENT

NOTE

- Verify the meter needle is at zero; if not, perform the following procedure.

1. Remove power from the MM-100. Disconnect MM-100 POWER Connector (56) from Communications Service Monitor.

2. Use SCREWDRIVER (67) and rotate METER Zero Adjustment (50) to align meter needle with zero on meter scales.

4-3 SEMI-CONDUCTOR CHECKS

An added feature of the MM-100 Multi-Meter is the ability to check semi-conductors. MM-100 characteristics that provide this feature are: a one volt potential exists on the probe in "OHMS" position and the design of MM-100 ohm circuitry which selects source impedance by the RANGE control.

1. Connect MM-100 POWER Connector (56) to FM/AM-1000S or FM/AM-1000A EXT ACC Connector (20).

2. Apply power to the Communications Service Monitor.

3. Connect Probe BNC Connector (59) to INPUT Connector (53).

4. Set FUNCTION Control (52) to "OHMS" position.

5. Set Probe Range Switch (61) to "X1" position.

6. Connect diode between Probe Clip (63) and Probe Ground Clip (60) in a forward biased condition.

7. Rotate RANGE Control (58) to "X1" position or as desired.

8. With diode under test forward biased, the forward voltage drop is read on V/% (0-10) SCALE (one volt full scale). Forward current may be calculated by using the following formula:

$$\text{Forward Current} = \frac{1 - \text{DISPLAYED VOLTAGE}}{\text{Source Impedance}}$$

RANGE SWITCH POSITION	SOURCE IMPEDANCE OHMS
X1	30
X10	300
X100	3K
X1K	30K
X10K	300K

9. With diode under test reverse biased, the result should be very high resistance as indicated on the METER Display (49).

4-4 OPERATING PARAMETERS

RANGE CONTROL POSITION	FUNCTION CONTROL POSITION	METER SCALE	METER RANGE	ACCURACY
SINAD	AC/LOAD 3.2, 8, 150, 600, HI-Z (NOTE 2)	SINAD	0-20 dB (NOTE 4)	±1.5 dB
DIST 0-30%	AC/LOAD 3.2, 8, 150, 600, HI-Z (NOTE 2)	V/%	0-30% (NOTE 5)	±4.5% Distortion
DIST 0-10%	AC/LOAD 3.2, 8, 150, 600, HI-Z (NOTE 2)	V/%	0-10% (NOTE 5)	±1.5% Distortion
AM%	SWITCH DISABLED	V/% (0-10) (10=100%)	90% Maximum Modulation	±3% Modulation at 30% Modulation for a Modulating Tone Freq. of 500 Hz to 1500 Hz.
OHMS X1, X10, X100, X1K, X10K	OHMS	OHMS	0-INFINITY (NOTE 1)	±5% at Mid Scale
DC VOLTS .1, .3, 1, 3, 10, 30, 100, 300	DC (NOTE 3)	V/%	Full Scale corresponds to RANGE SWITCH position	±3% FULL SCALE
AC VOLTS .1, .3, 1, 3, 10, 30, 100, 300	AC/LOAD 3.2, 8, 150, 600, HI-Z (NOTE 2) (NOTE 3)	V/%	Full scale corresponds to RANGE SWITCH position	±3% FULL SCALE

NOTE 1: The Probe Range Switch shall be set in the "X1" position.

NOTE 2: Selectable impedances: 3.2, 8, 150, 600, HI-Z (1 Megohm unbalanced).

NOTE 3: The X10 probe can be used in the HI-Z (1 Megohm unbalanced) position to increase range values by 10 times to a maximum of 600 V RMS and in DC position to increase range values 10 times to a maximum of 800 VDC.

NOTE 4: SINAD Measurements: 50 MV RMS to 22 V RMS input at 1 kHz ±20 Hz.

NOTE 5: Use an input level of 0.1 V to 3 V RMS and keep the AC voltage between case ground on the MM-100 input jack ground, to a minimum.

TABLE 4-1 METER MODE SWITCH POSITION

4-4 OPERATING PARAMETERS (CONT'D)

CONTROL	INITIAL SETTING
RANGE Control (58)	300 Position
FUNCTION Control (52)	HI-Z Position
VOL Control (57)	Full CCW
Probe Range Switch (61)	X1 Position

TABLE 4-2 INITIAL MM-100 CONTROL SETTINGS

Position	One Minute Duration 50% Duty Cycle	30 Second Duration 25% Duty Cycle	Continuous
3.2	10 Watts Maximum	20 Watts Maximum	5 Watts
8	10 Watts Maximum	20 Watts Maximum	5 Watts
150			½ Watt
600			1 Watt

TABLE 4-3 AC LOAD POWER LIMITATION

4-5 TEST PROCEDURES USING MM-100

4-5-1

TEST PROCEDURE: ***USE OF AUDIO MONITOR***

TEST OBJECTIVE: Monitor audio signal under test.

SPECIAL ACCESSORY EQUIPMENT REQ'D: MM-100 Probe and Probe Accessory Kit.

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set MM-100 controls to initial settings; refer to Table 4-2.
2.	Connect MM-100 Probe BNC Connector (59) to INPUT Connector (53).
3.	Select appropriate AC LOAD impedance on FUNCTION Control (52). (AC LOAD impedance positions are 3.2, 8, 150, 600, HI-Z).
4.	Apply power to Communications Service Monitor.
5.	Ground the Probe Ground Clip (60) to UUT.

NOTE

- Select appropriate accessory (63, 64, 65, 66) from Probe Kit to perform test.

6. If audio signal is above 300 V RMS, place Probe Range Switch (61) to "X10" position.

WARNING

- DO NOT ATTEMPT TO MEASURE AUDIO ABOVE 600 V RMS.

7. Place Probe (62) at test point of UUT.

8. Adjust audio VOL Control (57) for a comfortable level.

NOTE

- The audio monitor function may be used in all test procedures except OHM function and AM% modulation function.

4-5-2

TEST PROCEDURE: ***MEASURING AC VOLTAGE***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: MM-100 Probe and Probe Accessory Kit.

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set MM-100 controls to initial settings; refer to Table 4-2.
2.	Connect MM-100 Probe BNC Connector (59) to INPUT Connector (53).
3.	Select appropriate AC LOAD impedance on FUNCTION Control (52). (AC LOAD impedance positions are 3.2, 8, 150, 600, HI-Z).
4.	Apply power to Communications Service Monitor.
5.	Ground the Probe Ground Clip (60) to UUT.
6.	If voltage to be measured is above 300 V RMS, place Probe Range Switch (61) to "X10" position.

WARNING

- DO NOT ATTEMPT TO MEASURE VOLTAGE ABOVE 600 V RMS.

NOTE

- Select appropriate accessory (63, 64, 65, 66) from Probe Kit to perform test.

7.	Place Probe tip (62) at test point on UUT.
8.	To measure unknown voltage, set RANGE Control (57) to "300 VOLT" position; rotate RANGE SWITCH to lowest range setting to provide maximum needle deflection without moving needle OFF the meter scale.

STEP	PROCEDURE

9. Read the result using the following scale:

RANGE Control (58) Position 100, 10, 1, .1	RANGE Control (58) Position 300, 30, 3, .3
V/% (0-10) SCALE (49A)	V/% (0-30) SCALE (49B)

NOTE

- Check the Probe Range Switch (61); if the Probe Range Switch (61) is in the "X10" position, multiply the RANGE Control (58) setting by 10.

4-5-3

TEST PROCEDURE: ***MEASURING DC VOLTAGE***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: MM-100 Probe and Probe Accessory Kit.

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set MM-100 controls to initial settings; refer to Table 4-2.
2.	Connect MM-100 Probe BNC Connector (59) to INPUT Connector (53).
3.	Set FUNCTION Control (52) to "DC+" or "DC-" position corresponding to positive or negative dc voltage to be measured.
4.	Apply power to Communications Service Monitor.
5.	Ground Probe Ground Clip (60) to UUT.

NOTE

- Select appropriate accessory (63, 64, 65, 66) from Probe Kit to perform test.

6. If voltage to be measured is above 300 VDC, place Probe Range Switch (61) to "X10" position.

WARNING

- DO NOT ATTEMPT TO MEASURE VOLTAGE ABOVE 800 VDC.

7. Place Probe tip (62) at test point on UUT.

STEP	PROCEDURE

8. To measure unknown voltage, set RANGE Control (58) to "300 VOLT" position; rotate RANGE Control (58) to lowest range setting to provide maximum needle deflection without moving needle off the meter scale.

9. Read the result using the following scale:

RANGE Control (58) Position 100, 10, 1, .1	RANGE Control (58) Position 300, 30, 3, .3
V/% (0-10) SCALE (49A)	V/% (0-30) SCALE (49B)

NOTE

- Check the Probe Range Switch (61); if the Probe Range Switch (61) is in the "X10" position, multiply the RANGE Control (58) setting by 10.

TEST PROCEDURE: ***GENERATING AM MODULATED RF SIGNALS***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: N/A

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set MM-100 controls to initial settings; refer to Table 4-2.
2.	Set RANGE Control (58) to "AM%" position.
3.	Use applicable FM/AM-1000S or FM/AM-1000A Operation Manual and perform procedure 4-5-3, titled "GENERATING RF SIGNALS."
4.	Set AM/FM Switch (19) to "AM" position.
5.	Select "1000.0 Hz" on MODULATION FREQ Hz Thumbwheels (25).
6.	Rotate INT MOD Control (23) "cw" until meter indicates desired percent of modulation as displayed on V/% (0-10) SCALE (49A).

NOTE

- The FM/AM-1000S or FM/AM-1000A signal generator is now calibrated to desired percent modulation and is generating at selected frequency and output level.

4-5-5

TEST PROCEDURE: ***MEASURING AM MODULATION OF A TRANSMITTER***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D:

2 50 ohm coax cables with BNC connector on one end and appropriate UUT connector on the other end.

1 DC blocking capacitor

TEST SET-UP DIAGRAM:

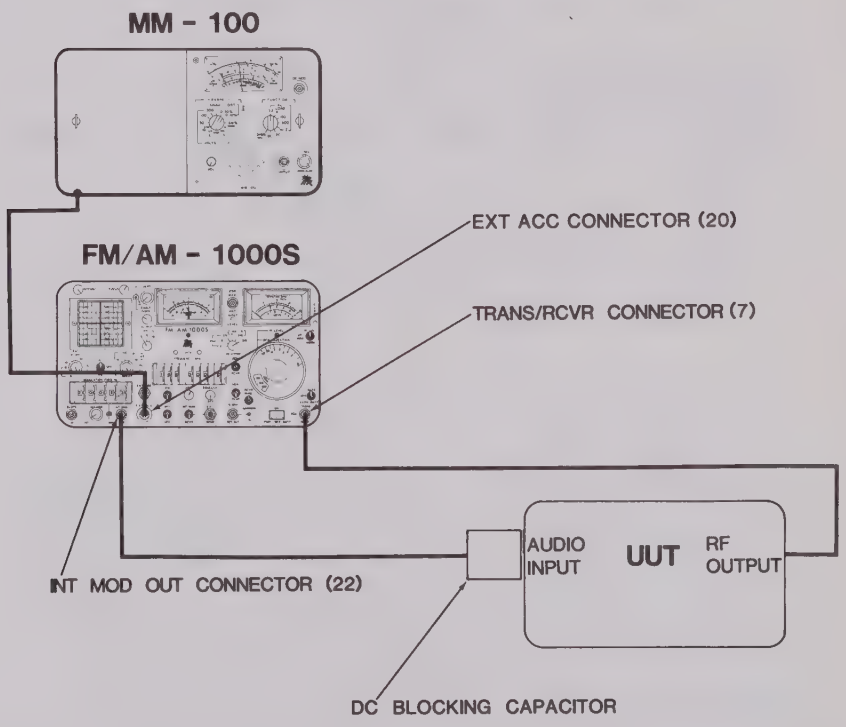


FIGURE 4-1 TEST SET-UP DIAGRAM FOR MEASURING AM MODULATION OF A TRANSMITTER

STEP	PROCEDURE
1.	Set MM-100 controls to initial settings; refer to Table 4-2.
2.	Perform procedure 4-5-9, titled "GENERATING AUDIO TONES OF KNOWN AMPLITUDE."

NOTE

- Amplitude of 1 kHz audio tone must be within limits of UUT input specifications.

STEP	PROCEDURE

3. Connect coax cables as illustrated in Test Set-Up Diagram.

NOTE

- Tone injection point on UUT is Audio Input point.

4. Set Communications Service Monitor controls for AM receiver operation; refer to applicable FM/AM-1000S or FM/AM-1000A Operation Manual.

NOTE

- Do not alter setting of INT MOD Control (23).

5. Place RANGE Control (58) to "AM%" position.

6. Read the result from V/% (0-10) SCALE (49A).

NOTE

- When measuring AM modulation, interpret V/% (0-10) scale (49A) as 10 = 100.

4-5-6A

TEST PROCEDURE: ***MEASURING DISTORTION OF AN AUDIO AMPLIFIER***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: 2 Oscilloscope probes (if audio amplifier under test (UUT) has terminating connectors, use 50 ohm coax cables with appropriate connectors).

Optional: To display 1 kHz audio signal on oscilloscope, additional 50 ohm coax with BNC connectors and BNC tee connector are required.

TEST SET-UP DIAGRAM:

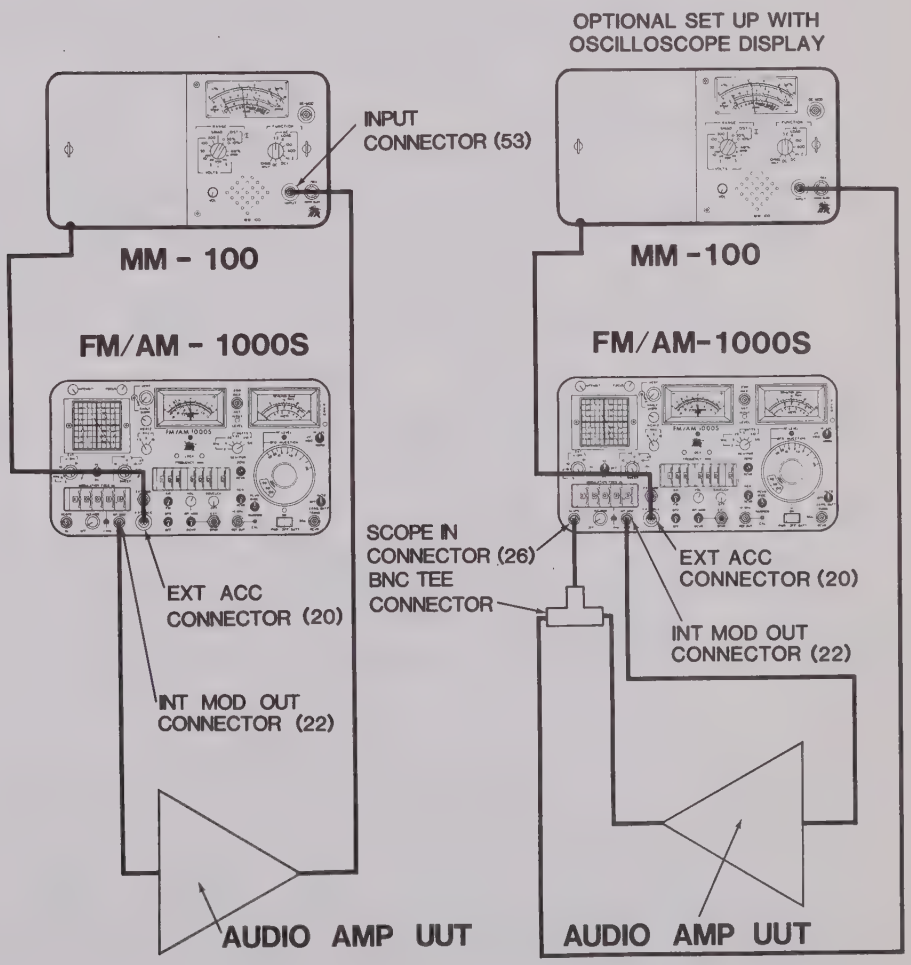


FIGURE 4-2 TEST SET-UP DIAGRAM FOR MEASURING DISTORTION OF AN AUDIO AMPLIFIER

STEP	PROCEDURE
1.	Set MM-100 controls to initial settings; refer to Table 4-2.
2.	Set MODULATION FREQ Hz Thumbwheels (25) to "1000.0 Hz".
3.	Remove coax cable connected to INPUT Connector (53).
4.	Set FUNCTION Control (52) to appropriate AC LOAD position.
5.	Rotate INT MOD Control (23) fully "ccw" (detent position).
6.	Connect UUT in accordance with Test Set-Up Diagram.

NOTE

- If oscilloscope is to be used, refer to applicable FM/AM-1000S or FM/AM-1000A Operation Manual Section 4-2 for Oscilloscope Operation.

7. Apply power to UUT.

8. Rotate INT MOD Control (23) "cw" in conjunction with audio gain control of UUT for maximum rated audio power output of UUT.

9. Set RANGE Control (58) to DIST "0-10%" position.

CAUTION

- DO NOT EXCEED AC LOAD POWER LIMITATION; REFER TO TABLE 4-3.

10. Read result on V/% (0-10) SCALE (49A). If meter needle deflects OFF scale, set RANGE Control (58) to DIST "0-30%" and read the result on V/% (0-3) SCALE (49B).

4-5-6B

TEST PROCEDURE: ***MEASURING DISTORTION OF A RECEIVER***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: 2 50 ohm coax cables with appropriate connectors.

TEST SET-UP DIAGRAM:

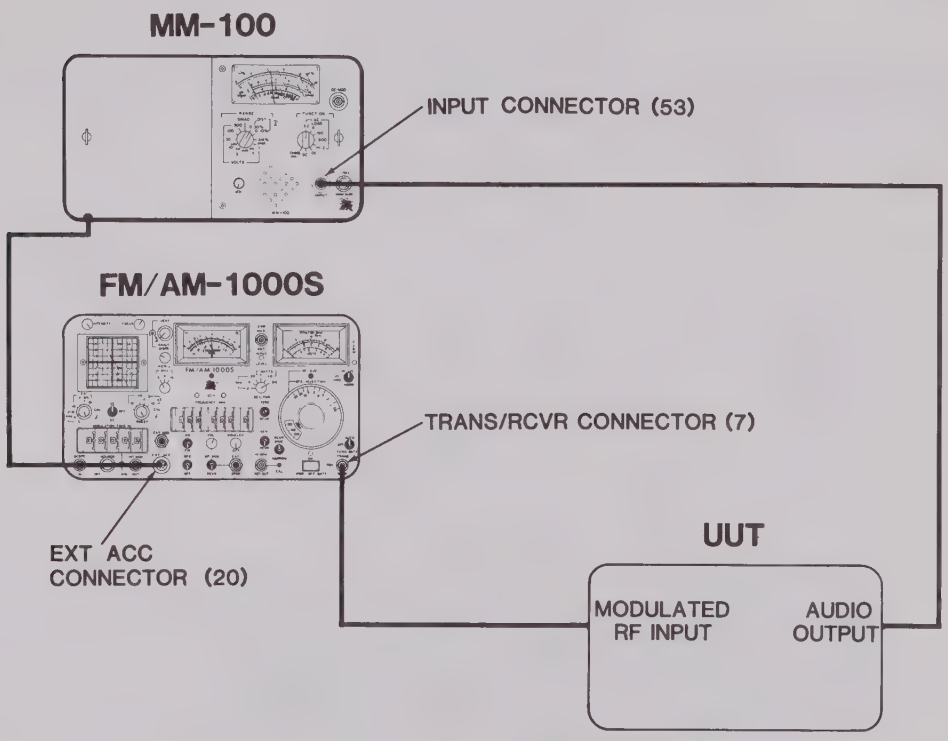


FIGURE 4-3 TEST SET-UP DIAGRAM FOR MEASURING DISTORTION OF A RECEIVER

STEP	PROCEDURE
1.	Set MM-100 controls to initial settings; refer to Table 4-2.
2.	Perform this procedure for AM receiver. For FM receiver, refer to applicable FM/AM-1000S or FM/AM-1000A Operation Manual and perform procedure 4-5-5, titled "GENERATING FM MODULATED RF SIGNALS", except set MODULATION FREQ Hz Thumbwheels (25) to "1000.0 Hz".
3.	Set FUNCTION Control (52) to appropriate AC LOAD impedance.
4.	Connect UUT in accordance with Test Set-Up Diagram.

TEST PROCEDURE

5. Apply power to UUT.

6. Adjust UUT audio gain control for maximum rated audio power output of UUT.

CAUTION

- DO NOT EXCEED AC LOAD POWER LIMITATION; REFER TO TABLE 4-3.

7. Read result on V/% (0-10) SCALE (49A). If meter needle deflects OFF scale, set RANGE Control (58) to "DIST 0-30%" and read the result on V/% (0-3) SCALE (49B).

4-5-6C

TEST PROCEDURE: ***MEASURING DISTORTION OF A TRANSMITTER***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D:

1 50 ohm coax cable with BNC connectors.

2 50 ohm coax cables with a BNC connector on one end and appropriate UUT connector on the other end.

1 DC blocking capacitor.

Optional: To display 1 kHz audio on oscilloscope, additional 50 ohm coax cable with BNC connectors and a BNC tee connector are required.

TEST SET-UP DIAGRAM:

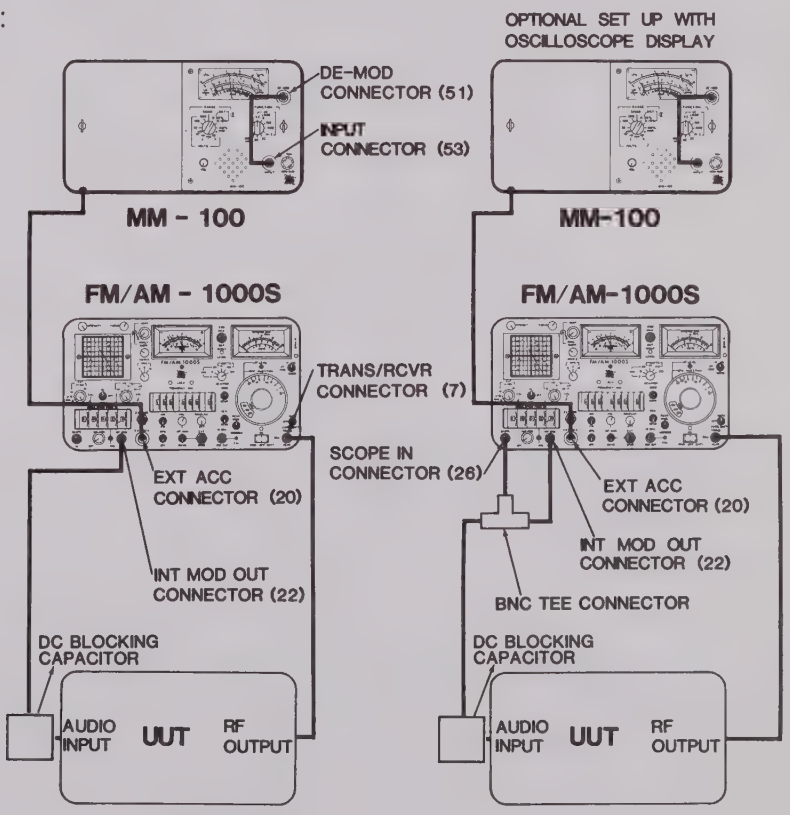


FIGURE 4-4 TEST SET-UP DIAGRAM FOR MEASURING DISTORTION OF A TRANSMITTER

STEP	PROCEDURE
1.	Refer to applicable FM/AM-1000S or FM/AM-1000A Operation Manual and perform procedure 4-6-3, titled "RECEIVING AM OR FM SIGNALS", (Steps 1 thru 7).
2.	Perform procedure 4-5-9, titled "GENERATING AUDIO TONES OF KNOWN AMPLITUDE."
3.	Set MM-100 controls to initial settings; refer to Table 4-2.
4.	Connect UUT in accordance with Test Set-Up Diagram.

NOTE

- If oscilloscope is to be used, refer to applicable FM/AM-1000S or FM/AM-1000A Operation Manual Section 4-2 for Oscilloscope Operation.

5.	Set RANGE Control (58) to "DIST 0-10%" position.
6.	Read result on V/% (0-10) SCALE (49A). If meter needle deflects OFF scale, set RANGE Control (58) to "DIST 0-30%" position and read the result on V/% (0-3) SCALE (49B).

TEST PROCEDURE: ***MEASURING RESISTANCE***

TEST OBJECTIVE: N/A

SPECIAL ACCESSORY EQUIPMENT REQ'D: MM-100 Probe and Probe Accessory Kit.

TEST SET-UP DIAGRAM: N/A

STEP	PROCEDURE
1.	Set MM-100 controls to initial settings; refer to Table 4-2.
2.	Set FUNCTION Control (52) to "OHMS" position.
3.	Connect Probe BNC Connector (59) to INPUT Connector (53).

NOTE

- Select appropriate accessory (63, 64, 65, 66) from Probe Kit to perform test.

4. Set RANGE Control (58) to "X1" position.

5. Connect Probe Ground Clip (61) and Probe tip (62) across resistance under test.

CAUTION

- DO NOT ALLOW THE PROBE TIP OR PROBE GROUND CLIP TO CONTACT LIVE CIRCUITS OR CHARGED CAPACITORS WHEN FUNCTION CONTROL (52) IS SET TO "OHMS" POSITION.

6. Rotate RANGE Control (57) to ohm range to provide meter needle deflection to center scale.

7. Read the result on the OHM SCALE (49E) and multiply the meter needle indication by the selected range multiplier on the RANGE Control (58).

4-5-8

TEST PROCEDURE: ***MEASURING 12 dB SINAD SENSITIVITY***

TEST OBJECTIVE: To measure the amount of input signal a receiver requires to produce an audio output 12 dB above noise and distortion output levels.

SPECIAL ACCESSORY EQUIPMENT REQ'D: 2 50 ohm coax cables with BNC connectors on one end of the cable and appropriate UUT connectors on the other end.

TEST SET-UP DIAGRAM:

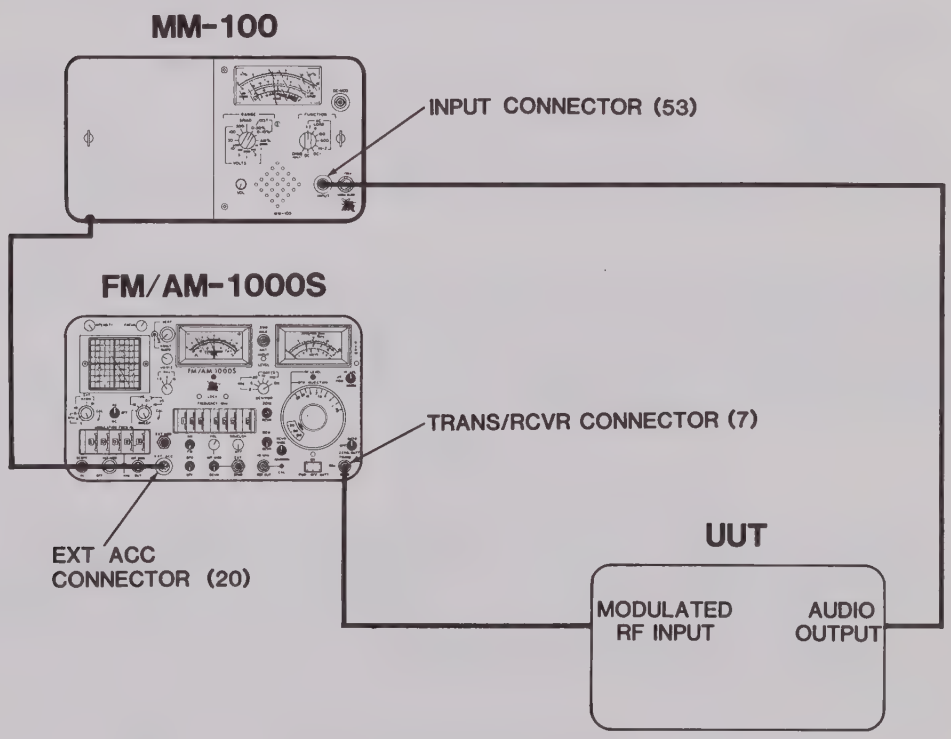


FIGURE 4-5 TEST SET-UP DIAGRAM FOR MEASURING 12 dB SINAD SENSITIVITY

STEP	PROCEDURE
1.	Set MM-100 controls to initial settings; refer to Table 4-2.
2.	Set FM/AM-1000S or FM/AM-1000A switches and controls for RF Generator Operation; refer to applicable FM/AM-1000S or FM/AM-1000A Operation Manual procedure 4-8-12, titled "MEASURING 12 dB SINAD SENSITIVITY", Step 1.
3.	Connect UUT in accordance with Test Set-Up Diagram.
4.	Set FUNCTION Control (52) to appropriate AC LOAD position.
5.	Apply power to UUT and Communications Service Monitor.
6.	Set MODULATION FREQ Hz Thumbwheels (25) to "1000.0 Hz" position.
7.	Set FREQUENCY Hz Thumbwheels (32) to the receiver frequency of the UUT.
8.	Set DEV/PWR Control (47) to appropriate "kHz" position (2, 6, 20).
9.	Rotate INT MOD Control (23) "cw" until DEVIATION/WATTS Meter (1) indicates two-thirds (2/3) of UUT peak deviation.
10.	Rotate RF LEVEL/BFO INJECTION Dial (5) "cw" until the FM/AM-1000S is generating an RF signal to quiet the receiver.

NOTE

- If result obtained in Receiver Sensitivity Test is above -85 dBm, place HI LVL/µV X 100/NORM Switch (3) to "µV X 100" position. Rotate RF LEVEL/BFO INJECTION Dial (5) "cw" to a setting 30 dB below result obtained in Receiver Sensitivity Test.

EXAMPLE:

If receiver sensitivity was established at -75 dBm, place HI LVL/µV X 100/NORM Switch (3) to "µV X 100" position. Rotate RF LEVEL/BFO INJECTION Dial (5) until dBm scale indicates -105 dBm.

(-75 dB) + (-30 dB) = -105 dBm

TEST	PROCEDURE

11. Adjust UUT audio output to maximum rated power level (refer to UUT specifications).

CAUTION

- DO NOT EXCEED AC LOAD POWER LIMITATION; REFERENCE TABLE 4-3.

12. Set RANGE Control (58) to "SINAD" position.

13. Rotate RF LEVEL/BFO INJECTION Dial (5) "ccw" until MM-100 meter needle aligns with 12 dB on SINAD SCALE (49D). The present setting of RF LEVEL/BFO INJECTION Dial (5) represents 12 dB SINAD sensitivity of UUT.

RESULT IN MICROVOLTS:

If "µV X 100" position was selected on the HI LVL/µV X 100/NORM Switch (3), multiply the microvolt indication on RF LEVEL/BFO INJECTION Dial (5) by 100.

RESULT IN dBm:

If µV X 100 was selected on the HI LVL/µV X 100/NORM Switch (3), add +40 dBm to indication on RF LEVEL/BFO INJECTION Dial (5); the result will be expressed in dBm.

MP MASTER
MA30399